2013
CITY OF REDMOND, WASHINGTON
CITYWIDE WATERSHED MANAGEMENT PLAN

Prepared for
City of Redmond
Public Works Natural Resources Division

Prepared by
Herrera Environmental Consultants, Inc.

HERRERA

Note:
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CITYWIDE WATERSHED MANAGEMENT PLAN

Prepared for
City of Redmond
Public Works Natural Resources Division
Andy Rheaume, Senior Watershed Planner
15670 NE 85th Street
Redmond, Washington 98052

Prepared by
Herrera Environmental Consultants, Inc.
2200 Sixth Avenue, Suite 1100
Seattle, Washington 98121
Telephone: 206/441-9080

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ACKNOWLEDGMENTS

City of Redmond

Elected Officials

John Marchione - Mayor

Kim Allen – Council Member
David Carson – Council Member
Tom Flynn – Council Member
Hank Margeson – Council Member
Hank Myers – Council Member
John Stilin – Council Member
Pat Vache – Council President

Project Team

Andy Rheaume – Project Manager

Cathy Beam – Principal Planner
Roger Dane – Stream Enhancement Planner
Steve Hitch – Stormwater Engineer
Joel Pfundt – Transportation Planner
B Sanders – Park Planner
Peter Sullivan – Long Range Planner

Washington State Department of Ecology

Helen Bresler
Anne Dettelbach
Ed O'Brien, P.E.

Herrera Environmental Consultants

John Lenth – Project Manager

Dylan Ahearn
Amanda Azous
Neil Brauer
Craig Doberstein
Meghan Feller
Joy Michaud
Sue Wall

LIST OF ABBREVIATIONS AND ACRONYMS

AADT	Average Annual Daily Traffic
AKART	All known, available, and reasonable methods of prevention, control, and treatment
B-IBI	Benthic index of biotic integrity
BMP	Best management practice
CARA	Critical Aquifer Recharge Area
CFR	Code of Federal Regulations
City	City of Redmond
CIP	Capital Improvement Plan
CNT	Center for Neighborhood Technology
CSCP	Chinook Salmon Conservation Plan
CWA	Clean Water Act
EIS	Effective impervious surface
ESA	Endangered Species Act
Ecology	Washington State Department of Ecology
GMA	Growth Management Act
LID	Low impact development
MSL	Mean sea level
NGPE	Native Growth Protection Easement
NPDES	National Pollutant Discharge Elimination System
NRCS	Natural Resources Conservation Service
PCB	Polychlorinated biphenyl
PCE	Perchloroethylene
Phase II permit	Phase II Municipal Stormwater Permit
PGHS	Pollutant Generating Hard Surface
PGPS	Pollutant Generating Pervious Surface

PSRC	Puget Sound Regional Council
PSE	Puget Sound Energy
PSP	Puget Sound Partnership
state	Washington State
SMA	Shoreline Management Act
SMP	Shoreline Master Program
sq ft	Square foot or square feet
TMDL	Total maximum daily load
TMP	Transportation Master Plan
UIC	Underground Injection Control
U.S. EPA	United States Environmental Protection Agency
WAC	Washington Administrative Code
WLSP	West Lake Sammamish Parkway
WMP	Citywide Watershed Management Plan
WPCA	Washington Pollution Control Act
WQIP	Water Quality Implementation Plan
WRIA	Water Resource Inventory Area

"We shall never achieve harmony with the land, any more than we shall achieve absolute justice or liberty for people. In these higher aspirations the important thing is not to achieve but to strive."

— Aldo Leopold, *Round River: From the Journals of Aldo Leopold*

EXECUTIVE SUMMARY

The City of Redmond (City) has identified factors critical to its vision of ensuring a clean and green environment for the future. To create and maintain a clean and green environment we must protect the natural resources that nourish and sustain us physically, emotionally, and spiritually. Maintaining and restoring healthy habitats and ecosystems will help accomplish our goals of clean air, water, and soil, while also nurturing our desire for beautiful places that can be enjoyed by the community. The City's responsibility to provide key services to protect the health of its community and the environment is a primary impetus behind this Citywide Watershed Management Plan (WMP).

"The environment is where we all meet, where all have a mutual interest; it is the one thing we all share. It is not only a mirror of ourselves, but a focusing lens on what we can become."

- Lady Bird Johnson

This Watershed Management Plan is intended to restore Redmond's surface waters, provide a coordinated framework for addressing multiple regulatory drivers, while supporting future development.

The City has more than 50 miles of local streams in addition to two major creeks, the Sammamish River, and Lake Sammamish. These surface waters are valued City assets that have been adversely impacted by development.

This WMP guides actions to restore these surface waters based on a holistic approach to surface water management. The plan identifies the target conditions to which we will restore our surface waters, major factors that play a role in surface water conditions, and opportunities to support and restore healthy surface waters. It prioritizes areas for action, and sets a basis for measuring and evaluating performance. The WMP will help restore Redmond's surface waters, provide a coordinated framework for addressing multiple regulatory drivers, and support future development.

Redmond is taking a watershed-based approach to surface water management to be more strategic with resources, projects, and programs. When applied city-wide, this approach is expected to produce more immediate and measurable positive results relative to the current approach that relies on uncoordinated regulatory drivers to achieve incremental, site-by-site improvements in stormwater management as land is developed or redeveloped over an extended period. Redmond is implementing this approach to achieve the goal of rehabilitating all the City's surface waters over the next 50 to 100 years.

Redmond will target local streams based on existing habitat conditions. Streams that are only slightly impaired will be addressed first. This strategy will provide high quality habitat sooner, albeit in limited areas, as opposed to implementing incremental improvements in all streams that would not provide significant overall habitat benefits, potentially for decades. For streams that have significant degradation, the City will strive to lessen and eliminate further degradation until they are targeted for rehabilitation.

The WMP will be formally adopted by the City Council and will be updated every 5 years but will be reviewed annually to measure progress. The City will use an adaptive management based evaluation process to measure and ensure implementation success. As part of the adaptive management evaluation, the City will review all major capital projects and land use planning decisions referenced in this WMP. At each review, two separate but related questions will be answered: Is the WMP being implemented as intended? Are the rehabilitation goals for the City's waterbodies being met?

Based on a thorough watershed assessment the City has established four overall management strategies for Redmond's watersheds.

1. **Protection:** This management strategy category includes watersheds with fish bearing Class II streams that are considered relatively pristine. City actions in these watersheds will emphasize protection and preservation rather than rehabilitation. This category includes streams in the Redmond Watershed Preserve Park and Farrell McWhirter Park, which are Collin, Mackey, and Seidel creeks.

2. **Highest Restoration:** This management strategy category includes Bear, Clise, Evans, High School, Monticello, and Tosh creeks. These watersheds have surface waters that are impaired but have the most potential to support all beneficial uses. City actions in these watersheds will focus on implementing watershed rehabilitation measures to improve and restore all beneficial uses.

3. **Restoration:** Watersheds with streams that are impacted by urbanization but still have potential to support beneficial uses with substantial investment are included within this management strategy category. Water quality is impaired, stream corridors are typically only partially intact, and instream complexity is limited. These include Perrigo, Peters, Tylers, and Willows creeks, and the Sammamish River.

4. **Restoration Development:** Watersheds with streams significantly compromised in both the stream corridor as well as extensive impacts caused by watershed development are in this management strategy category. Included are Lake Sammamish and the following creeks: Country, Idylwood, Sears, Valley Estates, and Villa Marina.

The goal of this WMP is to eventually rehabilitate all of the City's impaired waterbodies. Furthermore, an interim goal has been established pursuant to this WMP to rehabilitate all waterbodies associated with Highest Restoration watersheds by 2060. In this context, the term *rehabilitate* means water quality standards will be met in each waterbody and the benthic index of biotic integrity (B-IBI) scores will be indicative of *good* (38 to 45) habitat conditions.

This WMP represents an innovative approach to solving the City's water resource issues and, with proper implementation, will achieve this important community objective.

Chapter 1 INTRODUCTION

The City of Redmond (City) has identified factors critical to its vision of ensuring a clean and green environment for the future. Factors integral to this vision that pertain to this Citywide Watershed Management Plan (WMP) include:

- Conserving and restoring natural resources
- Protecting watersheds and surface waters
- Exploring and utilizing innovative technologies and strategies to manage stormwater
- Protecting the health of the City's community through effective stormwater management based on best available science
- Developing strategic connections and partnerships between City departments, businesses, and the community to achieve a higher standard of environmental protection with less effort and cost.

***"Maintaining and restoring healthy habitats and ecosystems is a natural way to help accomplish our goal of clean air, water and soil, while also nurturing our desire for beautiful places."*- Redmond's Budgeting by Priorities, Request for Offers 2012**

The Watershed Management Plan embodies locally generated data that represents best available science to identify where Redmond can restore streams to be healthy and support salmon.

This plan will:

- **Conserve and restore natural resources**
- **Protect watersheds and surface waters**
- **Explore and utilize innovative technologies and strategies**
- **Provide effective stormwater management based on best available science**
- **Develop strategic partnerships**

To create and maintain a clean and green environment (natural and urban) for the community and future generations we must protect the resources that nourish and sustain us physically, emotionally, and spiritually. Maintaining and restoring healthy habitats and ecosystems will help accomplish our goal of clean air, water, and soil, while also nurturing our desire for beautiful places that are enjoyed by the community. Our responsibility to provide key services to protect the health of our community and the environment is a primary impetus behind this WMP.

Results from public value surveys have repeatedly shown that clean water and healthy aquatic ecosystems are a high priority for residents in the City (City of Redmond 2010a). Despite this public interest, most streams in Redmond have impaired water quality and altered hydrologic regimes due to the gradual conversion of much of the City's wetlands and forested areas over the past several decades to homes, businesses, and streets. While current stormwater management requirements are designed to protect surface water resources from development impacts, most of the City was developed under less stringent requirements that did not fully mitigate the effects of land use changes on the City's water resources. In addition, even some new developments cause a net negative impact to aquatic resources because they were vested under older, less protective, stormwater regulations.

In response, the City has updated development codes to provide adequate protection and developed this WMP for rehabilitating the City's waterbodies. This WMP specifically describes a watershed approach that focuses on improving the ecologic function of entire watersheds in order to rehabilitate surface waters within them. This approach is expected to produce more immediate and measurable positive results relative to the default approach that relies on uncoordinated regulatory drivers to achieve incremental, site-by-site improvements in stormwater management as land is developed or redeveloped over an extended period.

Also underlying the watershed approach to stormwater management is the City's Water Resources Strategic Plan. The City's Natural Resources Division of Public Works, with a citywide internal team, developed the Water Resources Strategic Plan in 2013. The purpose of the plan is to have a council adopted strategy for how the City will approach water resource management encompassing groundwater, surface water (lakes and streams), and stormwater infrastructure. The plan lays out the principles, goals, objectives, strategies, and tactics that will be used by the City to protect and improve water resources, to leave a lasting legacy of responsible stewardship. Using a watershed management approach to stormwater, groundwater, and surface water management is one of ten principles highlighted in the Water Resources Strategic Plan. The plan sets a goal to have all waterbodies in Redmond restored by 2110.

Using the watershed management approach identified in this WMP, the City will coordinate its own internal planning efforts with other state and federal regulatory drivers to direct rehabilitation projects to watersheds where they will provide the most benefit. At the same time, safeguards will be put in place to prevent further degradation in all of the City's surface waters. As individual waterbodies are rehabilitated, additional watersheds will be prioritized for improvement through updates to this WMP until all the City's waterbodies have been rehabilitated.

To provide a scientific basis for identifying the near-term priority watersheds (i.e., those with the most immediate potential for measurable gains), the City collected and developed data on watershed health (such as water quality, stream habitat quality, and biological diversity). These data are presented herein and used to determine the relative likelihood that specific waterbodies can be rehabilitated in response to watershed improvements. This approach will maximize the cost/benefit of each improvement project, reduce the amount of time it takes to see measurable improvements in specific waterbodies, and streamline the City's efforts towards rehabilitating all of its waterbodies as it continues to grow and develop. More generally, the watershed approach described in this WMP is also the recommended approach for addressing water resource problems based on national guidelines from the United States Environmental Protection Agency (U.S. EPA) (U.S. EPA 2008a).

In addition to addressing the City's needs, this WMP also complements and supports broader planning efforts for restoring surface waterbodies within the Puget Sound region. For example, the Puget Sound Partnership (PSP) has adopted ecosystem recovery targets for Puget Sound, which describe desired future conditions for human health and wellbeing, species and food webs, habitats, water quantity, and water quality (PSP 2011a). This WMP will directly address specific recovery targets that have been adopted by the PSP for improving water quality and the health of biological communities in small streams by 2020. Likewise, the Draft PSP Action Agenda (PSP 2011b) includes specific strategy recommendations to "use a comprehensive approach to manage urban stormwater runoff at the site and landscape scales", and includes specific recommendations for regulations to be aligned with watershed plans, including municipal, industrial, and construction National Pollutant Discharge Elimination System (NPDES) permits; nonpoint source control programs; critical areas ordinances; the Shoreline Management Act; State Environmental Policy Act; Endangered Species Act; and the Growth Management Act as warranted. Finally, the conservation strategy identified in the Lake Washington/Cedar/Sammamish Watershed (WRIA 8) Chinook Salmon Conservation Plan (LWCS/WRIA 8 2005) was used to inform the selection of watersheds to aid the recovery of salmonids in the City.

Because this WMP seeks to coordinate numerous City planning activities for improving water resources, it was developed by the City's Natural Resources Division, Public Works Department, in collaboration with the following additional City departments/divisions: Planning (Development Services and Long Range Planning), Parks and Recreation (Park Planning), and Public Works (Maintenance Division, Natural Resources, and Transportation Division). In addition, the City solicited input from other local and regional stakeholder groups during the development of this plan including the Muckleshoot Tribe and Washington State Department of Fish and Wildlife. Finally, because the watershed approach identified in this WMP presents a unique approach for meeting the default requirements that have been established by Washington State Department of Ecology (Ecology) for managing stormwater runoff and restoring waterbodies with impaired water quality, this WMP was submitted to Ecology, for formal review and documented support for the City's approach (see letter of support in Appendix A).

1.1 Goals and Objectives

Using the watershed approach outlined above, this WMP has been developed to meet the following specific goals and objectives:

- Generate a base of scientific information that can be used for evaluating the relative rehabilitation potential of the City's watersheds.
- Identify a subset of watersheds where there is the greatest potential to restore beneficial uses in the associated waterbodies as the highest priority for rehabilitation.
- Identify specific tools to rehabilitate the watersheds ranked as highest priority and complete the rehabilitation measures by 2060. In this context, the term rehabilitate means state water quality standards will be met in each waterbody and B-IBI scores will be indicative of *good* habitat conditions (38 to 45).

- Guide City activities that do not focus on the environment but nevertheless affect it, to ensure that activities foster healthier watersheds.
- Further align City actions within a regional planning framework, City policies, sustainability principles, and state and federal environmental regulations.
- Guide the use of City financial resources to achieve the greatest environmental benefits.

1.2 Geographic Scope

This WMP covers all incorporated areas of the City (Figure 1.1) including 20 separate watersheds. If the City incorporates new areas during the implementation period for this WMP, coverage would be extended to those areas.

1.3 Document Organization

This WMP presents the following information:

- **Chapter 2: Regulatory Drivers** – Background information on the primary regulatory drivers for water resources in the City
- ***Chapter 3: Watershed Condition*s** – Summary of existing watershed conditions within the City
- **Chapter 4: Watershed Planning Approach** – General overview of the approach that will be used to rehabilitate water resources under the WMP
- **Chapter 5: Watershed Needs Assessment and Rehabilitation Strategies** – Detailed descriptions of the specific activities that will be performed to rehabilitate water resources under the WMP
- **Chapter 6: Implementation Strategy** – Overview of plan implementation elements including general guidance, funding strategy, monitoring, and use of adaptive management

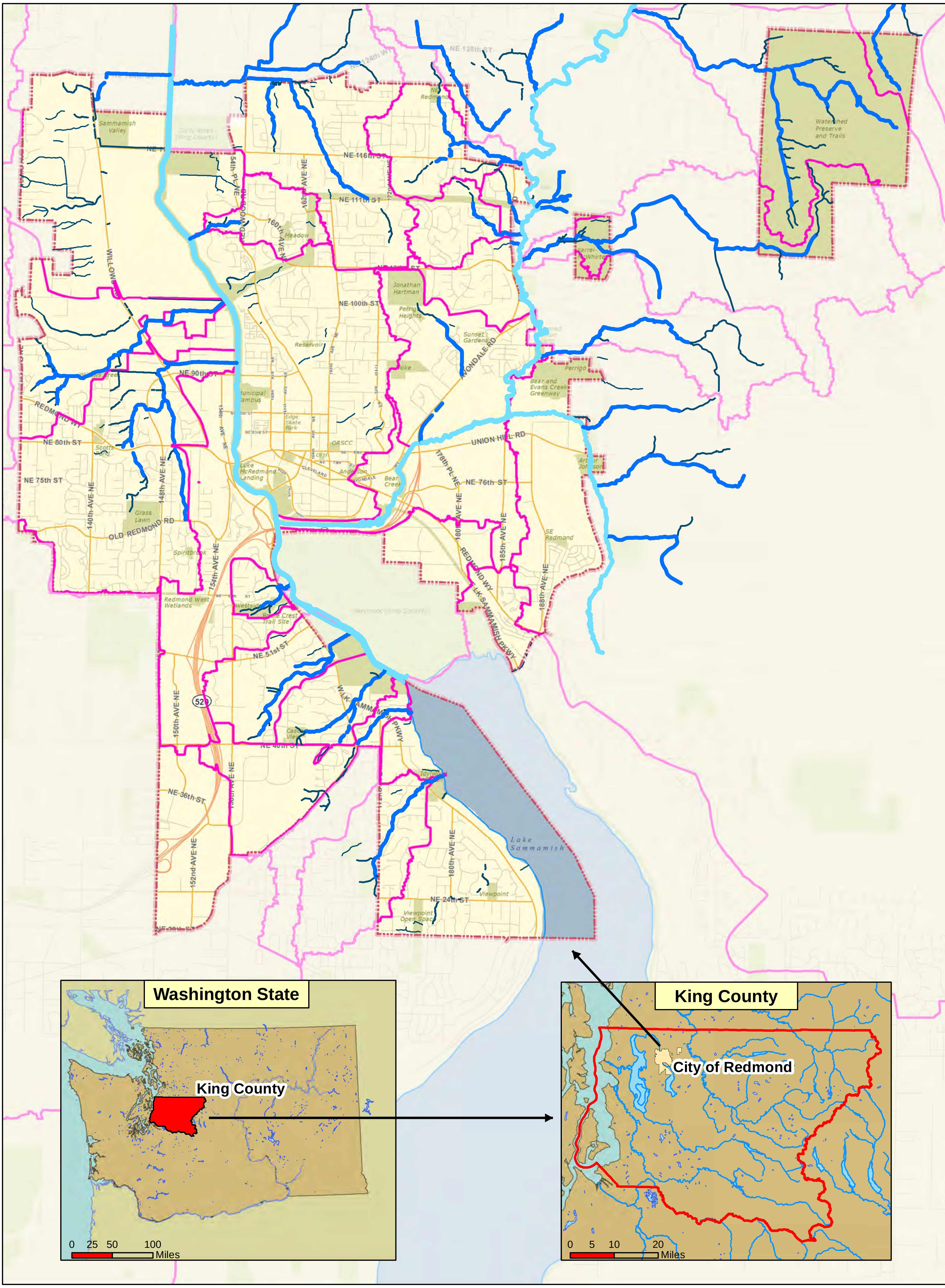


Figure 1.1 - Vicinity and Watershed Map for the City of Redmond

City of Redmond, Washington

11/22/2013

0 0.25 0.5 1 1.5 Miles

N

Legend

- Class I Stream
- Class II Stream
- Class III Stream
- Class IV Stream
- Watershed Boundary
- City Limits
- Lake Sammamish
- King County
- Redmond

Disclaimer: This map is created and maintained by the Natural Resources Division of the City of Redmond, Washington, for reference purposes only. The City makes no guarantee as to the accuracy or completeness of the features shown on this map.

Chapter 2 Regulatory Drivers

The City is complying with a number of state and federal regulations related to protecting or improving water resource conditions. Along with other requirements, these regulations call for the City to maintain or improve surface and groundwater water quality, manage stormwater runoff volumes to protect stream habitat, and preserve sensitive areas such as vegetated buffers around streams and wetlands. One of the primary goals of this WMP is to better align the City's comprehensive planning framework with these various state and federal regulations to achieve more immediate and measurable improvements to water resource conditions. The primary regulatory drivers related to the goals of this WMP as described in *Chapter 1: Introduction* are summarized below.

This plan will work in concert with: Redmond's Comprehensive Plan, Redmond's Shoreline Management Plan, the WRIA 8 Salmon Recovery Plan, Puget Sound Partnership Action Agenda, Washington State Water Pollution Control Act, and the federal NPDES permit program.

- **Regulations require the City to manage stormwater to protect stream habitat, and preserve sensitive areas.**
- **With this WMP, the City is complying with state and federal regulations related to protecting and improving water resources.**
- **This WMP aligns the City's comprehensive watershed planning framework with state and federal regulations to achieve more immediate and measurable improvements to water resources.**

2.1 Growth Management Act

In 1990, the Washington State (state) legislature passed the Growth Management Act (GMA) establishing planning goals and a planning framework for cities and counties. The GMA specifically requires counties above a stated population level or rate of increase (and cities within those counties) to prepare 20-year comprehensive plans that address land use, rural use (counties only), housing, capital facilities, utilities, and transportation. More broadly, a comprehensive plan is a statement of the community's vision for the future regarding the natural and built environments. In keeping with this idea, the GMA also established 13 planning goals to guide the preparation of local comprehensive plans and regulations. Pursuant to these goals, local governments are to direct most growth into urban areas, require adequate transportation facilities for new development, protect natural resource lands and environmentally critical areas, encourage economic development, and protect property rights.

GMA planning activities are also intended to be coordinated with other state acts that set forth policies and regulations for the control of water pollution in the state, most notably the Washington Pollution Control Act (WPCA) (see description in Clean Water Act subsection below). For example, RCW 36.70A.020(1) states that comprehensive plans must “protect the environment and enhance the state’s high quality of life, including air and water quality.” Washington State Department of Commerce (DOC) regulations (WAC 365-195-700) also state: “for local jurisdictions subject to its terms, the Growth Management Act mandates the development of comprehensive plans…these plans and regulations will take their place among existing laws relating to resource management, environmental protection, regulation of land use, utilities and public facilities. Many of these existing laws were neither repealed nor amended by the [GMA] act.”

The City completed a major update to its Comprehensive Plan in 2011 (City of Redmond 2011a). In response to GMA requirements for periodic plan review, this update provides a planning framework for activities through 2030.

2.2 Shoreline Management Act

Washington’s Shoreline Management Act (SMA) was passed by the legislature in 1971 and affirmed by voters in 1972. The overarching goal of the SMA is "to prevent the inherent harm in an uncoordinated and piecemeal development of the state’s shorelines." The SMA applies to all cities and counties that have Shorelines of the State (RCW 90.58.030(2)) within their boundaries. Shorelines of the State include land areas extending 200 feet landward from the edge of:

- All marine waters
- Streams and rivers with greater than 20 cubic feet per second mean annual flow
- Lakes 20 acres or larger
- Wetlands and river deltas when they are associated with one of the above

At the discretion of the local government, all or a larger portion of the 100-year floodplain may also be included within its shoreline jurisdiction as long as, at a minimum, the floodway and the adjacent land extending landward 200 feet from the floodway boundary are included.

Under the SMA, each city and county with Shorelines of the State, which includes the City, must prepare and adopt a Shoreline Master Program (SMP) that is based on state laws and rules but is tailored to the specific geographic, economic, and environmental needs of the community. The SMP identifies allowable activities and uses within shoreline areas. The SMP must also establish antidegradation policies to prevent the loss of functions associated with ecosystem-wide processes as well as localized processes that can significantly impact shoreline natural resources as well as human health and safety.

The City’s SMP (City of Redmond 2011b) was approved by Ecology and adopted in 2010. Pursuant to the criterion identified above, the following waterbodies within the City are Shorelines of the State and therefore designated Class I:

- All lands extending landward 200 feet of the ordinary high water mark on the Sammamish River

- Lake Sammamish, its underlying land, associated wetlands and all areas within the one percent numerical probability floodplain (100-year floodplain) as defined by the most recent Federal Emergency Management Agency map or study, together with those lands extending landward 200 feet from the ordinary high water mark
- Bear Creek and Evans Creek where the mean annual flow is 20.0 cubic feet per second or greater and the land underlying the creek in those areas, associated wetlands, and all lands extending landward 200 feet from the ordinary high water mark on both sides of Bear Creek west of Avondale Road; all lands extending landward 200 feet from the ordinary high water mark on the south sides of Bear Creek east of Avondale Road and Evans Creek; and all lands extending landward 200 feet from the ordinary high water mark on the north side of Bear and Evans Creeks plus all areas within the 1 percent numerical probability floodplain (100-year floodplain) as defined by the most recent Federal Emergency Management Agency map or study.

2.3 Clean Water Act

Established in 1972, the federal Clean Water Act (CWA) requires the identification and cleanup of polluted surface waters, and establishes water quality standards for surface waters throughout the United States. In addition, the CWA regulates discharges to surface waters by requiring NPDES permits for discharges to receiving waters from municipal, industrial, and other regulated point and "nonpoint" (diffused and dispersed across the landscape) sources (see more detailed discussion in *NPDES* subsection below). Specific sections of the CWA also require preparation of a list of impaired waterbodies (Section 303(d) list) and permit approvals, such as Section 401 Water Quality Certifications, to ensure CWA standards are met. Within Washington State, the U.S. EPA has delegated administration of these CWA requirements to the state. In addition, the state regulates water quality through the Washington Pollution Control Act (WPCA).

Surface water quality standards for the state are established in Chapter 173-201A of the Washington Administrative Code (WAC) (Ecology 2006). The purpose of these standards is to designate "beneficial uses" for surface waterbodies and establish specific chemical and physical criteria for protecting these uses. Beneficial uses and include public water supply, protection for fish, shellfish, and wildlife, as well as recreational, agricultural, industrial, navigational and aesthetic purposes. Specific use designations for waterbodies in Washington are listed in WAC 173-201A-600 and 173-201A-602. There are different water quality standards for freshwaters (streams, rivers, and lakes) and marine waters. The surface water quality standards also establish an antidegradation process that helps prevent unnecessary lowering of water quality, and provides a framework to identify those waters that are designated as an "outstanding resource" by the state.

The Section 303(d) list of impaired waterbodies is periodically updated by Ecology and submitted to the U.S. EPA for review and approval. Ecology currently submits these lists on a 2-year alternating cycle of the freshwater listing and the marine water listing. At the time this WMP was written, Ecology had submitted the final 2010 marine waters list to the U.S. EPA in fall of 2011. Ecology will submit the next assessment, and freshwater listing to the U.S. EPA for approval in 2013.

In developing the Section 303(d) list, Ecology identifies five categories of water quality health:

1. **Category 1** – Meets Tested Standards for Clean Waters
2. **Category 2** – Waters of Concern
3. **Category 3** – Insufficient Data
4. **Category 4** – Polluted Waters that do not require a Total Maximum Daily Load (TMDL) limit of targeted pollutant(s) to achieve the surface water quality standards. Three subcategories are:
    - **Category 4a** – Has an approved TMDL study in place
    - **Category 4b** – Has a pollution control program in place that is being implemented and is expected to achieve compliance with state water quality standards
    - **Category 4c** – Is impaired by a non-pollutant
5. **Category 5** – Polluted waterbodies that require a TMDL

Category 5 waterbodies are placed on the state's 303(d) list of impaired waterbodies. Pursuant to CWA requirements, the state must perform a TMDL study for all Category 5 waterbodies identified on the Section 303(d) lists. A TMDL specifies the maximum amount of a pollutant that a waterbody can receive and still meet the water quality standards. Furthermore, a TMDL identifies the sum of the allowable loads of a single pollutant from all point and nonpoint sources and determines a margin of safety to ensure that the waterbody can be protected in case there are unknown pollutant sources or unforeseen events that may impair water quality. The process of calculating and documenting a TMDL typically involves a number of tasks, including characterizing the impaired waterbody and its watershed, identifying sources, setting targets, calculating the loading capacity using some analysis to link loading to water quality, identifying source allocations, preparing a TMDL report, and coordinating with stakeholders (U.S. EPA 2008b). TMDL implementation is also a complex process that involves applying the pollution control practices necessary to reduce the pollutant loads to the extent determined necessary in the TMDL. These practices usually consist of point source control permits or nonpoint source control BMPs. The process of completing all these tasks is costly and time consuming, often requiring years to finish just the TMDL study and implementation plan.

Given this consideration, the U.S. EPA and Ecology (2011a) have established a process that allows local communities to forgo the formal TMDL planning process if they take the initiative to create a program to clean up polluted waters. Because these programs are locally controlled, there is an opportunity to reduce overall costs, and the communities can exert greater control over the cleanup process. Once a pollution control program is in place and being successfully implemented to address a specific source of impairment for a Category 5 waterbody, it can be designated a Category 4b waterbody on the Section 303(d) list, indicating a TMDL is no longer required.

The most recent 303(d) list for freshwaters identifies several impaired Category 5 streams in the City (see discussion in *Chapter 3: Watershed Conditions*). There are also existing TMDL studies (Ecology 2008a, 2008b) and a water quality implementation plan to address bacteria, temperature and dissolved oxygen impairments (Ecology 2011b) for the Bear-Evans Watershed, which is partially within the City's jurisdiction.

2.4 NPDES

The NPDES permitting program was developed to control the discharge of point sources of pollution such as from pipes and sewers to the nation's waters and is the primary regulatory vehicle for management of stormwater quantity and quality impacts on surface waters (40 Code of Federal Regulations [CFR] 122.26(d)). As described in the proceeding subsection, within Washington, the U.S. EPA has delegated administration of the NPDES program to the state.

In response to the 1987 amendments to the CWA, which included regulation of stormwater discharges under the NPDES permitting program, Phase I of the program was initiated in 1990 and requires medium and large cities or certain counties with populations of 100,000 or more to obtain NPDES permit coverage for their stormwater discharges. In 1999, Phase II of the program was initiated and requires smaller cities and counties with lower populations (including the City) to obtain NPDES permit coverage for their stormwater discharges.

The City's primary requirements for stormwater management are identified in its NPDES Western Washington Phase II Municipal Stormwater Permit (Phase II permit). Ecology first issued the Phase II permit in 2007; a modification in 2009 extended the effectiveness of this permit through February 15, 2012. Ecology subsequently reissued this permit with no modification on August 1, 2012, to be effective through July 31, 2013. Ecology also reissued an updated Phase II permit on August 1, 2012, with an effective date of August 1, 2013, and an expiration date of July 31, 2018.

The NPDES Phase II permit requires the City to establish requirements to implement stormwater best management practices (BMPs) for some new development or redevelopment projects. These BMPs may include traditional facilities such as stormwater ponds and underground stormwater vaults, as well as more innovative low impact development (LID) approaches such as rain gardens and green roofs. These BMPS are designed to remove pollutants from stormwater runoff (provide runoff treatment) and reduce stormwater peak flow rates and volumes (provide flow control) to prevent channel erosion in down gradient rivers and streams.

However, the permit also allows municipalities to use watershed planning to tailor the runoff treatment, flow control, and LID requirements to local needs and opportunities (see Section 7 of Appendix 1 to the NPDES Phase II permit). In order for a watershed plan to serve as a means of modifying the minimum requirements, the following conditions must be met:

- The plan must be formally adopted by all jurisdictions with responsibilities under the plan.
- All ordinances or regulations called for by the plan must be in effect.

- The watershed plan must be reviewed and approved by Ecology.

The City has developed tailored minimum requirements for runoff treatment, flow control, and LID through the development of this WMP (see discussion in *Chapter 4: Watershed Planning Approach*).

2.5 WRIA 8 Salmon Recovery Plan and Endangered Species Act

As the state's population has grown, its salmon populations and their critical habitat have dwindled. In 1991, the federal government declared the first salmonid species in the Pacific Northwest, Snake River sockeye, as endangered under the federal Endangered Species Act (ESA). In the next few years, 16 more species of salmon were listed as either threatened or endangered. By 1999, wild salmon had disappeared from about 40 percent of their historic breeding ranges in Oregon, Washington, Idaho, and California.

In Washington State, the numbers had dwindled so much that salmon and bull trout were listed as threatened or endangered in nearly three-fourths of the state. The ESA and Washington State law require development of recovery plans for salmon populations with these listings. Each recovery plan must include the following elements:

- Measurable goals for delisting the species from the ESA
- Factors limiting viability
- Actions to address limiting factors
- Recovery cost estimates

There are eight salmon recovery regions in the state, each with multiple subregions called Water Resource Inventory Areas (WRIAs).The City is located within the WRIA 8 subregion and contributed to the development of and continues to collaborate on the implementation of the associated Chinook Salmon Conservation Plan (CSCP). This plan was jointly developed by 27 local governments and lays out a 10-year strategy for the protection and recovery of two distinct population segments of Chinook salmon. The CSCP identifies programs and projects that collectively aim to perpetuate Chinook salmon populations. One of the distinct population segments is called the Sammamish population. This strain spawns in tributaries to the Sammamish River and northern Lake Sammamish, including the following waterbodies within the City: Bear Creek, Evans Creek, and the Sammamish River (see additional discussion in *Chapter 3: Watershed Conditions*).

Streams that are regulated under locally adopted SMPs as Shorelines of the State (see description in *Section 2.2: Shoreline Management Act*) are designated as Class I. Class I streams in the City were categorized in the CSCP based on relative watershed conditions, and Chinook abundance and use (LWCS / WRIA 8 2005). Core and migratory subareas are considered to have the highest quality habitat and highest fish abundance or use, while satellite subareas have the most degraded habitat and infrequent Chinook use. These Chinook habitat assignments are used to prioritize implementation efforts. For example, in core and migratory subareas protection and conservation are priorities, whereas in satellite subareas priorities are more likely to focus on rehabilitation. Table 2.1 provides the results of the

Chinook habitat evaluation of watersheds from the CSCP planning process for Class I streams within the City.

Table 2.1 Chinook Habitat Watershed Evaluations for Redmond Area Class I Streams.

Chinook Salmon Conservation Plan Area/Subarea	Use and Function
Lower Bear	Core Chinook Use / Moderate watershed function
Evans	Satellite Chinook Use / High Watershed Function
Upper Sammamish Valley	Migratory Chinook Use / Moderate watershed Function

While the CSCP is focused on Chinook recovery, there are other protected species the City is concerned about including coho salmon, a species of concern under both the ESA and Washington Department of Fish and Wildlife's (WDFW) Priority Habitats and Species program (PHS). In particular, coho salmon are widely distributed in Redmond area streams, and will spend up to two years in freshwater. Coho adults, eggs, and juveniles are highly sensitive to the peak flows and stormwater pollutants that are often associated with urban development.

2.6 Groundwater Regulations

Groundwater quality protection standards for the state are defined by Ecology in Chapter 173-200 WAC (Ecology 2010). The goal of the standards is to maintain groundwater quality and to protect existing and future beneficial uses through the reduction or elimination of contaminants discharged to the subsurface. Similar to the CWA, state groundwater regulations establish the following antidegradation policies:

- Existing and future beneficial uses shall be maintained and protected and degradation of groundwater quality that would interfere with or become injurious to beneficial uses shall not be allowed.
- Degradation shall not be allowed of high quality groundwaters constituting an outstanding national or state resource, such as waters of national and state parks and wildlife refuges, and waters of exceptional recreational or ecological significance.
- Whenever groundwaters are of a higher quality than the criteria assigned for said waters, the existing water quality shall be protected, and contaminants that will reduce the existing quality thereof shall not be allowed to enter such waters, except in those instances where it can be demonstrated to the department's satisfaction that:
    - An overriding consideration of the public interest will be served.
    - All contaminants proposed for entry into said groundwaters shall be provided with all known, available, and reasonable methods of prevention, control, and treatment prior to entry.

State law also sets requirements for wellhead protection programs (WAC 246-290-130 and 246-290-135 [Ecology 2011c]). In Washington, local wellhead protection programs must include:

- A completed susceptibility assessment
- A delineated Wellhead Protection Area for each well, well field, or spring
- An inventory of potential contaminant sources in the Wellhead Protection Area that could threaten the water-bearing zone (aquifer) used by the well, spring, or well field
- Documentation showing the water system owner sent delineation and inventory findings to required entities
- Contingency plans for providing alternate drinking water sources if contamination does occur
- Coordination with local emergency responders for appropriate spill or incident response measures

The City has developed a wellhead protection program pursuant to this requirement (see discussion in *Chapter 3: Watershed Conditions*). Wellhead protection programs, which are required for all large or public drinking water wells, are a proactive approach to preventing contamination of groundwater used for drinking water supplies. Wellhead protection programs identify potential sources of groundwater contamination, implementing strategies to prevent degradation, and managing existing sources of contamination to ensure appropriate actions have been taken to protect the drinking water supply.

Lastly, Ecology requires all injection wells, including stormwater infiltration wells (Class V wells), to be registered through the Underground Injection Control (UIC) program. This program requires all owners and operators of UIC wells to perform a self-assessment to safeguard groundwater from being contaminated by pollutants.

2.7 Muckleshoot Indian Tribe Treaty Rights

The Muckleshoot Indian Tribe (the Tribe) has treaty rights in the Lake Washington watershed that are protected through federal treaty and law. The Tribe is committed to protecting and restoring the abundance of salmon and the quality and quantity of fish habitat in the Lake Washington watershed so that fishing opportunities are preserved and improved over time.

The Tribe's Fisheries Division Habitat Program is tasked to protect and restore fish abundance, including water quality, so that tribal members can exercise their treaty-reserved commercial, subsistence, and ceremonial fishing rights now and in the future. Their challenge is that some fish populations in WRIA 8 have declined to the point that Tribal members cannot even exercise subsistence-level fishing rights while the abundance of other species populations in most years are too low to meet tribal needs. In recent years, limited Muckleshoot tribal fisheries have been scheduled at times in WRIA 8 for coho, sockeye, and Lake Sammamish Chinook salmon. Due to concerns over this issue, the Tribe has been active in efforts to improve fisheries resources in the Lake Washington watershed.

Chapter 3 WATERSHED CONDITIONS

> • **Existing watershed conditions within the City are summarized and include local climate, topography, soils, groundwater, and the condition of major creeks, the Sammamish River, and Lake Sammamish.**

This chapter summarizes existing watershed conditions within the City including climate, topography, soils, groundwater, and the condition of Class I and Class II waterbodies. This summary is generally based on the following sources in addition to specific references provided in the discussions. These documents supplement what is summarized in the sections that follow:

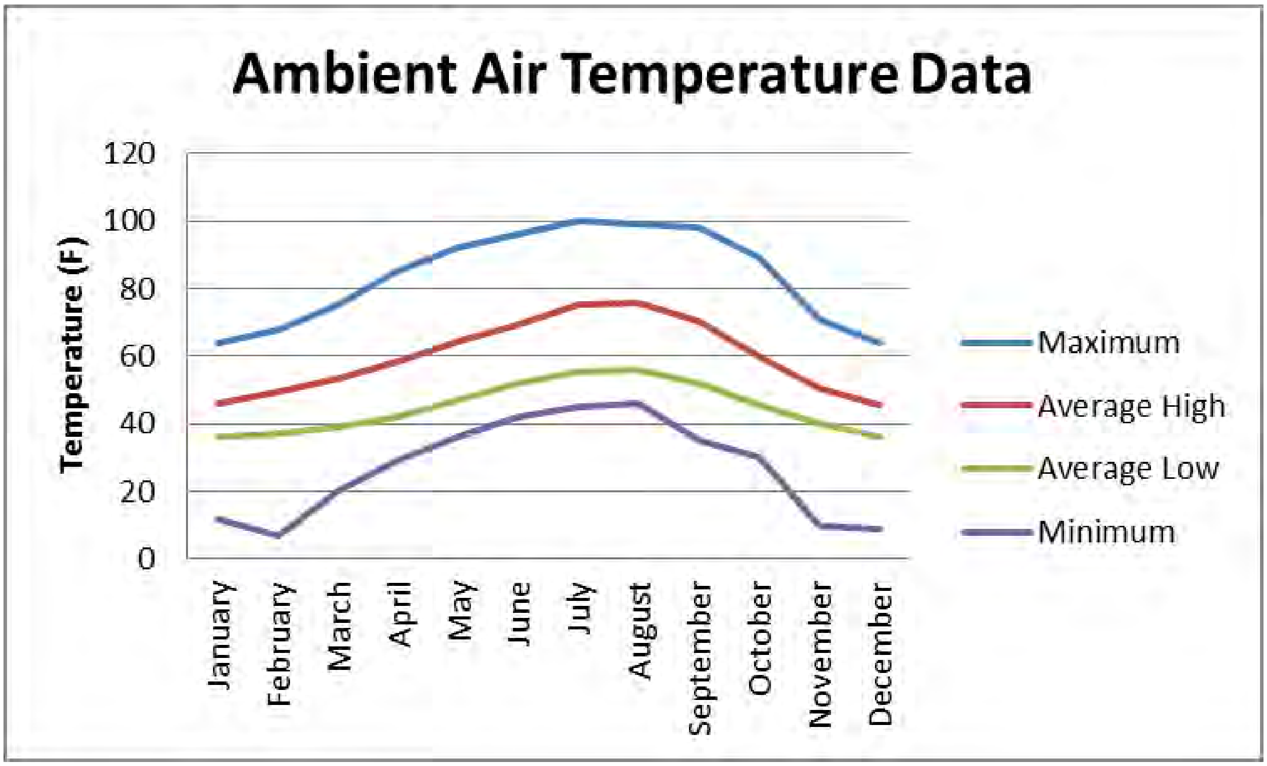
- Water Quality Assessment for Washington (http://www.ecy.wa.gov/PROGRAMS/WQ/303d/index.html)
- Bear-Evans Watershed Fecal Coliform Bacteria Total Maximum Daily Load: Water Quality Improvement Report (June 2008) (http://www.ecy.wa.gov/pubs/0810026.pdf)
- Bear-Evans Watershed Temperature and Dissolved Oxygen Total Maximum Daily Load: Water Quality Improvement Report (September 2008) (http://www.ecy.wa.gov/pubs/0810058.pdf)
- Annual Benthic Monitoring Program, City of Redmond (http://pugetsoundstreambenthos.org/Projects/Default.aspx?P=58)
- Redmond, WA Fish and Fish Habitat Distribution Study 2004–2005 (http://www.washingtontrout.org/redmond/index.shtml)
- Redmond Urban Watersheds Initiative (October 2008) (http://www.ci.redmond.wa.us/cms/One.aspx?portalId=169&pageId=3887)
- Salmon and Steelhead Habitat Limiting Factors Report for the Cedar-Sammamish Basin (Water Resource Inventory Area 8) (September 2001) (http://www.pugetsoundnearshore.org/supporting_documents/WRIA_8_LFR_FINAL.pdf)
- Lake Washington, Cedar, Sammamish Watershed (WRIA 8) Chinook Salmon Conservation Plan (CSCP) (July 2005) (http://www.govlink.org/watersheds/8/planning/chinook-conservation-plan.aspx)

3.1 Climate

Climate is an important factor in defining the key characteristics of a watershed. For example, the amount, timing, and form (rain or snow) of precipitation plays a role in determining the size and shape of streams and the frequency and intensity of flood events.

It also dictates many management decisions such as those related to stormwater and flood control infrastructure.

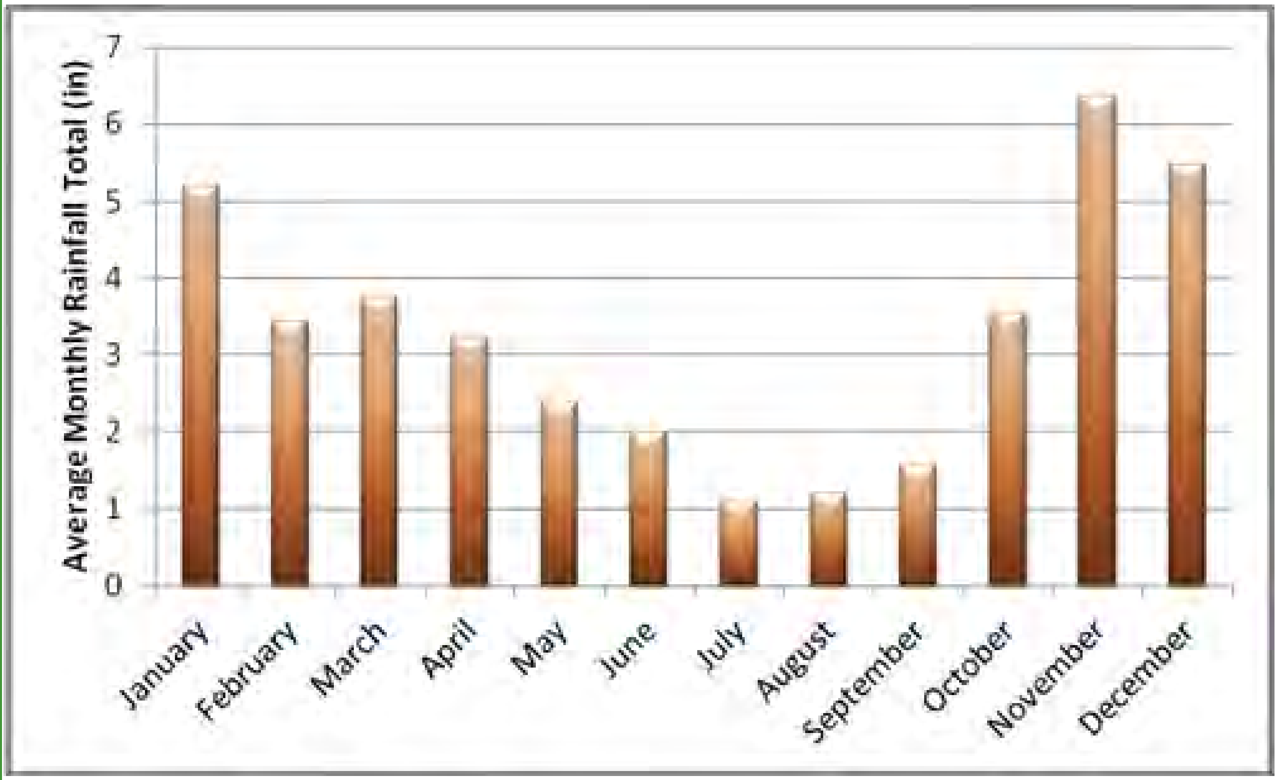
The City experiences the relatively mild weather conditions typical of the Puget Sound Region. The mean annual average temperature in the City is 52˚F (City of Redmond COC 2011). The warmest month is typically August with an average high temperature of 76˚F. The coolest months are December and January, when the average low temperature is approximately 35˚F. Figure 3.1 shows ambient air temperatures in the City based on data from the National Weather Service that were collected from 1971 through 2000.



Source: National Weather Service (1971-2000)

Figure 3.1. Ambient Air Temperatures in the City of Redmond.

Most precipitation in the City occurs during the cool, winter months as shown in Figure 3.2. Between November and March, average monthly precipitation totals range from 3.5 to 6.3 inches, while the months of May through September are generally dry and typically have precipitation totals of less than 3 inches. The high volume of rainfall received during the winter months, the intensity of this rainfall, and the fact that it often falls onto an already saturated watershed means that management of wet-weather stormwater is a critical function for the City. Winter rains are also the primary water source for recharging groundwater supplies. In turn, stored groundwater is the primary source for replenishing stream flows with cool water during the warmer summer months. In addition these wet-weather concerns, the City has also documented high pollutant concentrations in stormwater runoff during the summer and fall after prolonged periods of with no rain (Herrera 2013).



Source: Herrera (2009) (1989 to 2009)

Figure 3.2. Monthly Average Precipitation Totals for the City of Redmond from 1988-2008.

3.2 Topography and Soils

The City is located in the Puget Sound Lowlands, at an elevation ranging between 30 and 400 feet above mean sea level (MSL) (Figure 3.3). The Sammamish River valley begins at the north end of Lake Sammamish and extends to the north well beyond the City limits, ending at the north end of Lake Washington. The valley bottom is relatively wide and flat and prior to development was largely comprised of wetlands. The Sammamish River valley is bounded to the east and west by rolling hills that rise between about 30 and 350 feet above the valley. The valleys for Bear and Evans Creek drainages are also uniformly flat, rising gently to the east and both continue far outside city limits. A steep ridge to the northwest of Bear Creek separates the Bear-Evans Watershed from the Sammamish watershed. For reference, Figure 3.4 provides a generalized geologic cross-section of the city from west to east.

Most of the soils in the City are derived either from glacial outwash or till deposits; however, organic peat soils from the wetlands comprise much of the Sammamish River and Bear Creek valleys. The rate at which water infiltrates through a soil determines the amount of rainwater that is transported off the land surface as runoff, or that is infiltrated through the soil to groundwater. In general, glacial outwash and peat derived soils infiltrate water rapidly, while glacial till derived soils infiltrate water more slowly. Soils can generally be classified into four types (Types A, B, C, and D) depending upon their runoff potential. Figure 3.5 shows the extent and distribution of soils in the City based on their runoff potential or infiltration properties. All soils in the City have been categorized as either Type B or C based on a national hydrological model classification of City soils using Natural Resources Conservation Service (NRCS) soil types. Type B soils have a moderately low runoff potential or high infiltration capacity and cover about 16 percent (1,710 acres) of the City. Type C soils have moderately high runoff potential or low infiltration capacity, and cover about 84 percent (8,978 acres) of the City. This information is based on the NRCS national soils dataset; however, much higher variability exists in soil infiltration rates and runoff potential than is reflected in this dataset.

3.3 Existing Land Use and Land Cover

Since the 1970s, the majority of land in the City has been fully developed. For planning related to this WMP, the City is classified into one of nine existing land use categories based on similarities in population density, land use activity, effective impervious surface (EIS) (see definition below), and hydrologic response to rainfall. The City categorized land use at the parcel level to maximize accuracy. These land use categories are as follows:

- Commercial
- Industrial
- Roads
- Single-family residential – high density
- Single-family residential – medium density
- Single-family residential – low density
- Single-family residential – rural density
- Multifamily residential
- Parks and undeveloped land

The actual distribution of these land use categories within the City is shown on Figure 3.6.

In addition, the City used aerial photography (NHC 2006) to classify all the land area within its jurisdiction into one of three land cover categories: forested, pasture, and developed areas (Figure 3.7). Developed areas are a mix of landscaped and EIS. EIS refers to impervious area that is directly connected to the storm drain system and therefore contributes to increased runoff volumes and rates. The fractioning of parcels between landscaping and EIS was based on literature values for each land use category (e.g., commercial, single-family residential, etc.).

3.4 Groundwater

Protection of groundwater is a critical concern for the City largely because groundwater supplies the City's drinking water. There is a shallow, unconfined groundwater aquifer that underlies the Sammamish and Bear Creek Valley floor. This aquifer provides as much as 40 percent of the City's domestic water supply. Because it is shallow, in some places less than 5 feet below ground, and it has no natural barrier or confining layer to protect it, this aquifer is vulnerable to contamination. In addition to its importance for human use, movement of

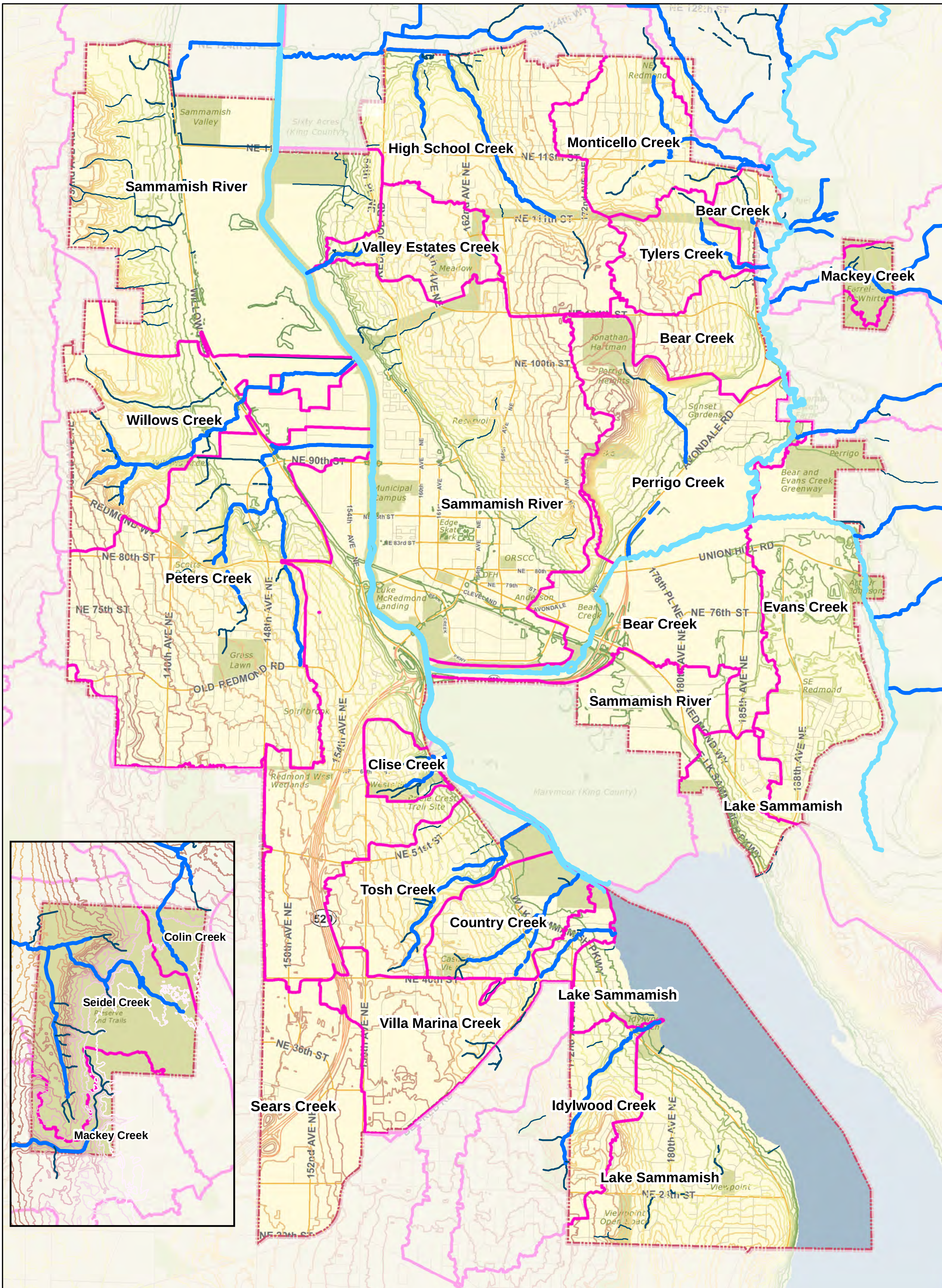


Figure 3.3 - Topography in the City of Redmond

City of Redmond, Washington

11/22/2013

City of Redmond WASHINGTON

0 0.25 0.5 1 Miles

Legend

Elevation

20 40 60 80 100 120 140 160 180 200 220 240 260 280 300 320 340 360 380 400 420 440 460 480 500 520 540

Class I Stream

Class II Stream

Class III Stream

Class IV Stream

Watershed Boundary

City Limits

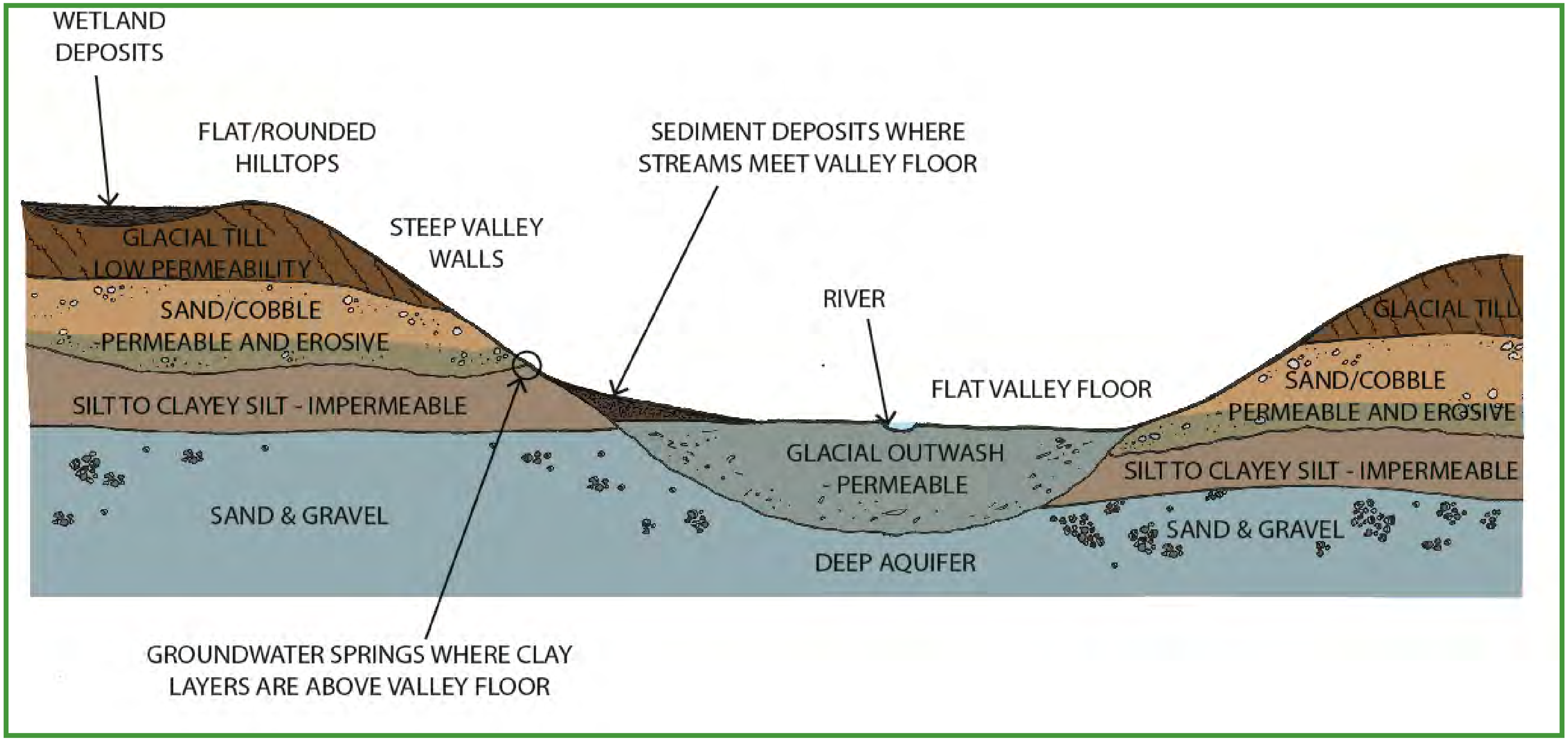


Figure 3.4. Geologic Cross-section of the City of Redmond and the Sammamish River Valley.

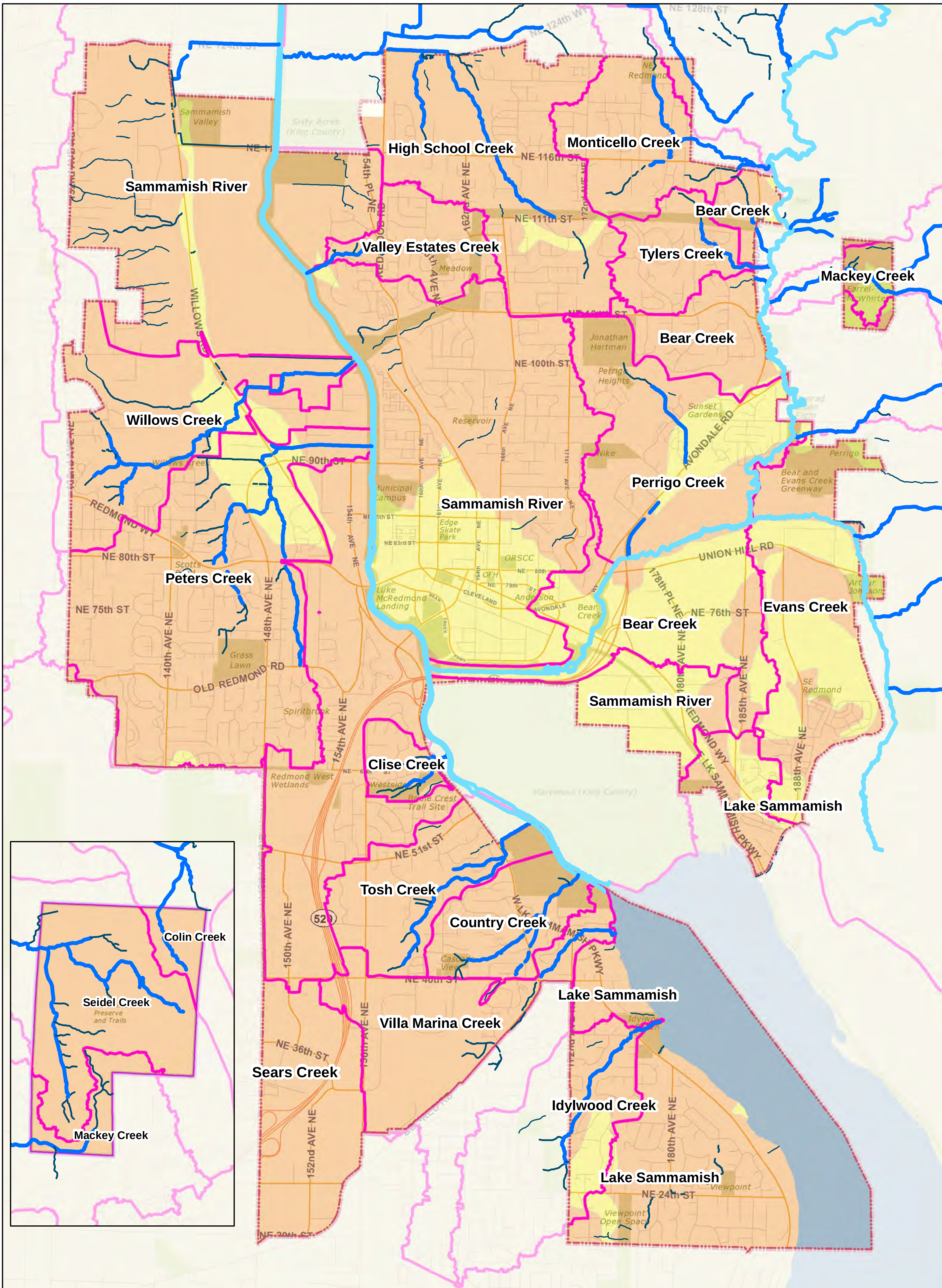


Figure 3.5 - Soil Types in the City of Redmond

City of Redmond, Washington

11/22/2013

Legend

- Class I Stream
- Class II Stream
- Class III Stream
- Class IV Stream
- City Limits
- Watershed Boundary
- B Soils
- C Soils

0 0.25 0.5 1 Miles

N

CityofRedmond WASHINGTON

Disclaimer: This map is created and maintained by the Natural Resources Division of the City of Redmond, Washington, for reference purposes only. The City makes no guarantee as to the accuracy or completeness of the features shown on this map.

Soils data based on Natural Resources Conservation Service (NRCS) soil types. Data collected Nov. 2011

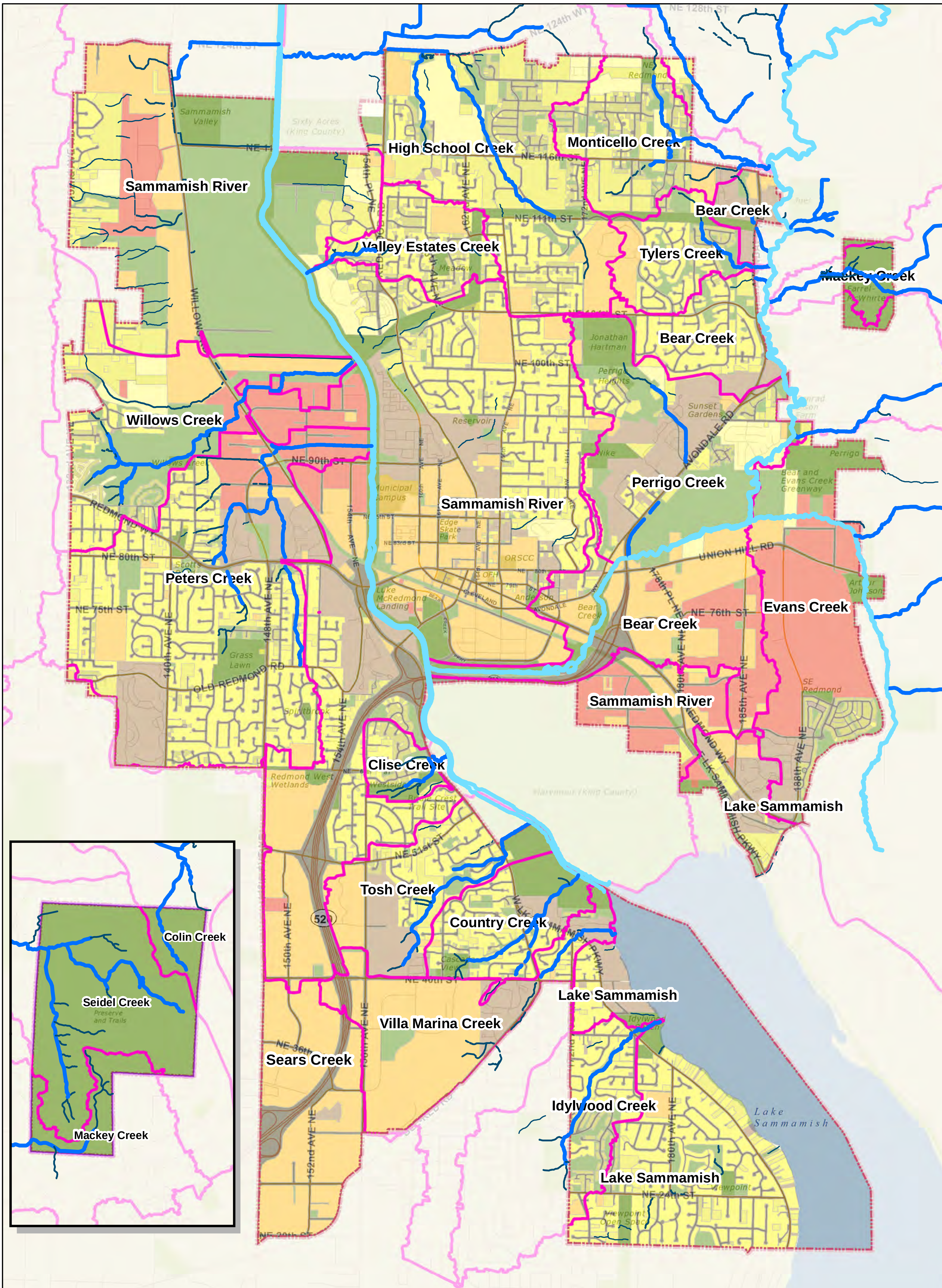


Figure 3.6 - Distribution of Existing Land Use Within the City of Redmond

City of Redmond, Washington

11/22/2013

0 0.25 0.5 1 Miles

N

City of Redmond WASHINGTON

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Land use data developed by City of Redmond Nov. 2011.

Legend

- Class I Stream
- Class II Stream
- Class III Stream
- Class IV Stream
- City Limits
- Watershed Boundary
- Commercial
- Industrial
- Multifamily
- Park / Undeveloped
- Road
- Single Family HighDensity
- Single Family Low Density
- Single Family Medium Density
- Single Family Rural Density

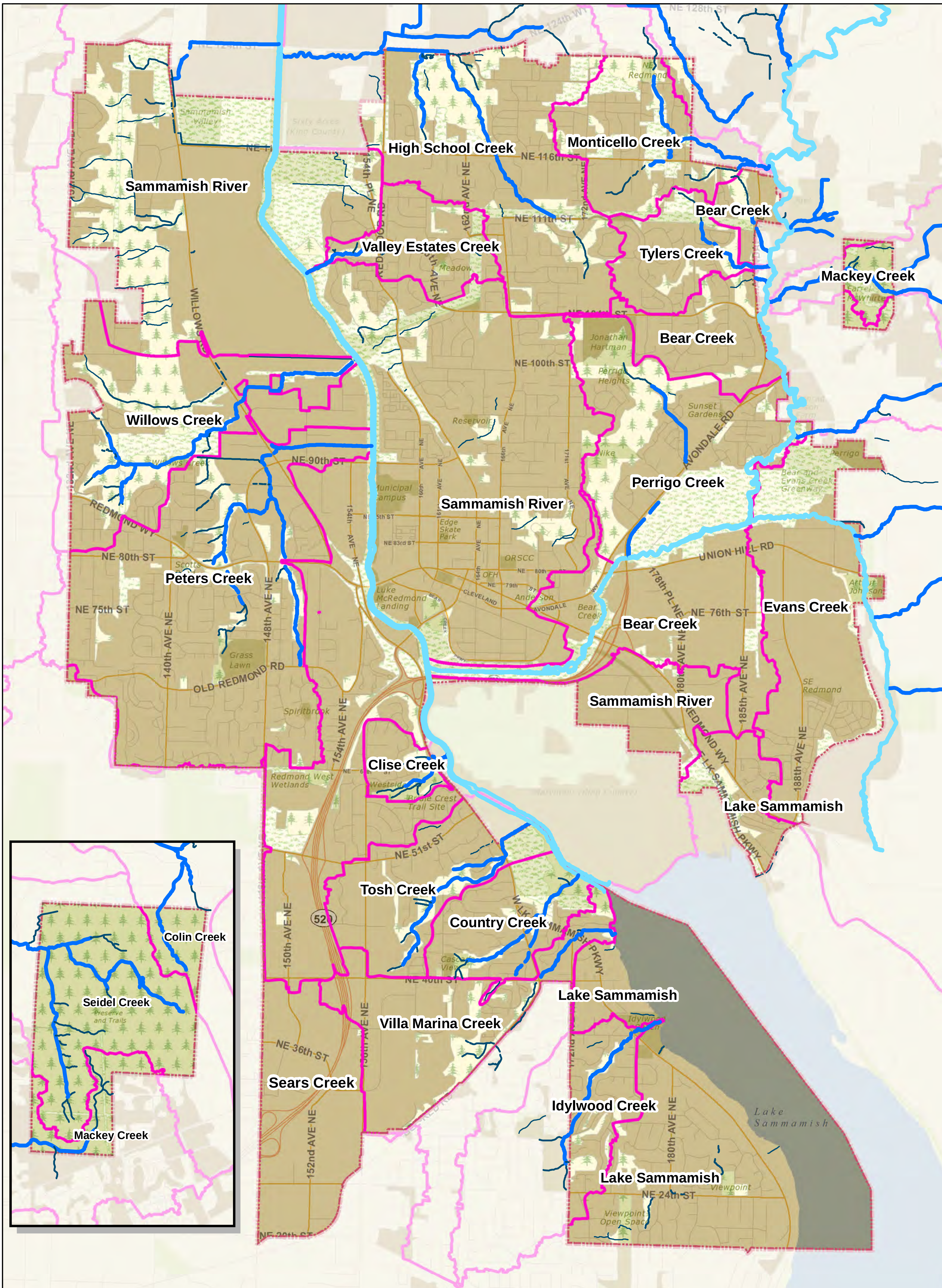

Figure 3.7 - Distribution of Existing Land Cover Within the City of Redmond

City of Redmond, Washington

11/22/2013

0 0.25 0.5 1 Miles

City of Redmond WASHINGTON

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Land cover data developed by Natural Resources Division Nov. 2011.

Legend

- Class I Stream
- Class II Stream
- Class III Stream
- Class IV Stream
- City Limits
- Watershed Boundary
- Forest
- Developed - Impervious and landscaped
- Pasture

water from the groundwater aquifer into local streams is critical for maintaining adequate stream flow and for cooling streams during summer months.

The City has been collecting groundwater data since 2007. In that year, 90 wells were selected for monitoring on a semiannual basis. Samples are tested for a myriad of constituents including nutrients, heavy metals, and a few other priority pollutants such as toluene and perchloroethylene (PCE). In general, groundwater quality is good and drinking water quality standards have been met for most constituents. Concentrations of iron and manganese and, to a lesser extent, arsenic commonly exceed drinking water quality standards; however, this is typical for groundwater supplies in the Puget Sound region (U.S. Geological Survey 1995). PCE has also occasionally been detected at levels in excess of the water quality standards in a few wells. PCE is a persistent organic solvent that is typically associated with the dry cleaning industry. PCE is highly mobile in soils, so when it is spilled or dumped on the land surface, it can rapidly migrate through the soil to the underlying groundwater.

The City adopted a Wellhead Protection Ordinance in 2003 and established a Wellhead Protection Program pursuant to Washington State requirements (see *Chapter 2: Regulatory Drivers*). As part of this process, an area called the Critical Aquifer Recharge Area (CARA) was delineated; this is the area with the most significant recharging effect on the aquifer. The CARA is divided into three wellhead protection zones (Figure 3.8). Wellhead protection zones depict the 6-month (Zone 1), 1-year (Zone 2), and 10-year (Zone 3) time of travel for groundwater to reach the supply wells (City of Redmond 2010c).

The City also collects water level data for its monitoring wells. Water level data has not been collected over a long enough period to evaluate trends in groundwater levels; however, over the long term, this data record will be instrumental in documenting whether environmental changes are affecting groundwater abundance.

3.5 Surface Waters of the City

The City's surface waters include all or portions of the Class I waterbodies, which are Lake Sammamish, the Sammamish River, Bear Creek, and Evans Creek, and 16 Class II streams. The City classifies the Sammamish River and City streams based on the Washington Department of Natural Resources stream typing system (that emphasizes salmonid use) and whether the stream or river is classified as a Shoreline of the State (see *Chapter 2: Regulatory Drivers*). All streams inventoried as a Shoreline of the State by the City's SMP are designated as Class I. Existing conditions for these streams are discussed briefly below. The City has been and will continue to participate in significant preservation and enhancement efforts on Class I streams through local and regional coordinated efforts.

Class II streams are defined as "those natural streams that are not Class I and are either perennial or intermittent and have salmonid fish use or the potential for salmonid fish use" (City of Redmond 2011b). Existing conditions for the 16 Class II streams in the City are also discussed briefly below.

Many of the Class II streams have Class III and Class IV tributaries. Class III streams have documented or potential presence of non-salmonid fish species, or are headwater streams connected to salmon-bearing streams. Class IV streams do not have any known fish use or potential fish habitat.

In general, a watershed is defined as the land area that drains to a specific waterbody (for example, a river, stream, or lake). The watersheds defined in this plan are largely located within an urban context and consequently the drainage patterns are often substantially altered. All watersheds delineated herein account for the urban storm drain network within and between topographic basins. It is important to note that many of the City's rivers and streams have some portion of the watershed in land areas that are outside the City's jurisdictional boundaries. As such, the City often has little control over activities that occur outside these boundaries that are contributing to overall water resource impairment. In this chapter, the information provided for existing conditions in each watershed applies only to the portion of the watershed that lies within City boundaries unless stated otherwise.

3.5.1 Class I Waterbodies

The Sammamish River, Bear Creek, Evans Creek, and Lake Sammamish have special designations under the SMP (City of Redmond 2011b), as described in the sections below. Pursuant to surface water quality standards for Washington State (WAC 173-201A), all of the Class I waterbodies shall be maintained to support the following designated uses: salmonid spawning, rearing, and migration; primary contact recreation; domestic, industrial, and agricultural water supply; stock watering; wildlife habitat; harvesting; commerce and navigation; boating; and aesthetic values.

Table 3.1 presents general information on water quality, land use and land cover for each Class I stream's watershed within the City. It also presents data on the following specific indicators of habitat integrity or health:

- **Observed salmonid use** — Chinook spawning, rearing and migration is from the Chinook Conservation Plan (LWCS/WRIA 8 2005). Other salmonid use is from WDFW (2011 and 2013) and from the WRIA 8 EDT Habitat Assessment Model Analytical Results for Bear Creek (coho and Chinook) (Mobrand Biometrics, Inc. 2003).
- **303(d) listing** — As described previously, under the CWA, certain waterbodies are identified on the Ecology 303(d) list as impaired. Impairments to the City's streams are due to high temperature, low dissolved oxygen, or the presence of fecal coliform bacteria.
- **Impervious surface** — This includes paved surfaces and buildings. The higher the percent, the flashier the flows in the receiving water, meaning stormwater rapidly increases the stream flow relative to natural conditions. In turn, these high flows cause channel scour and habitat destruction. Note that larger waterbodies such Lake Sammamish and the Sammamish River are not prone to scour. In addition, more pollutants from roadways, parking lots, and other built areas are flushed into nearby streams from impervious surfaces.
- **High average annual daily traffic (AADT) right-of-way** — This metric includes paved surfaces associated with roads with high traffic use. Runoff from roadways can contain a variety of pollutants such as petroleum and heavy metals that can be flushed into nearby streams (U.S. EPA 2008a). High road use can correlate with higher pollution accumulation.

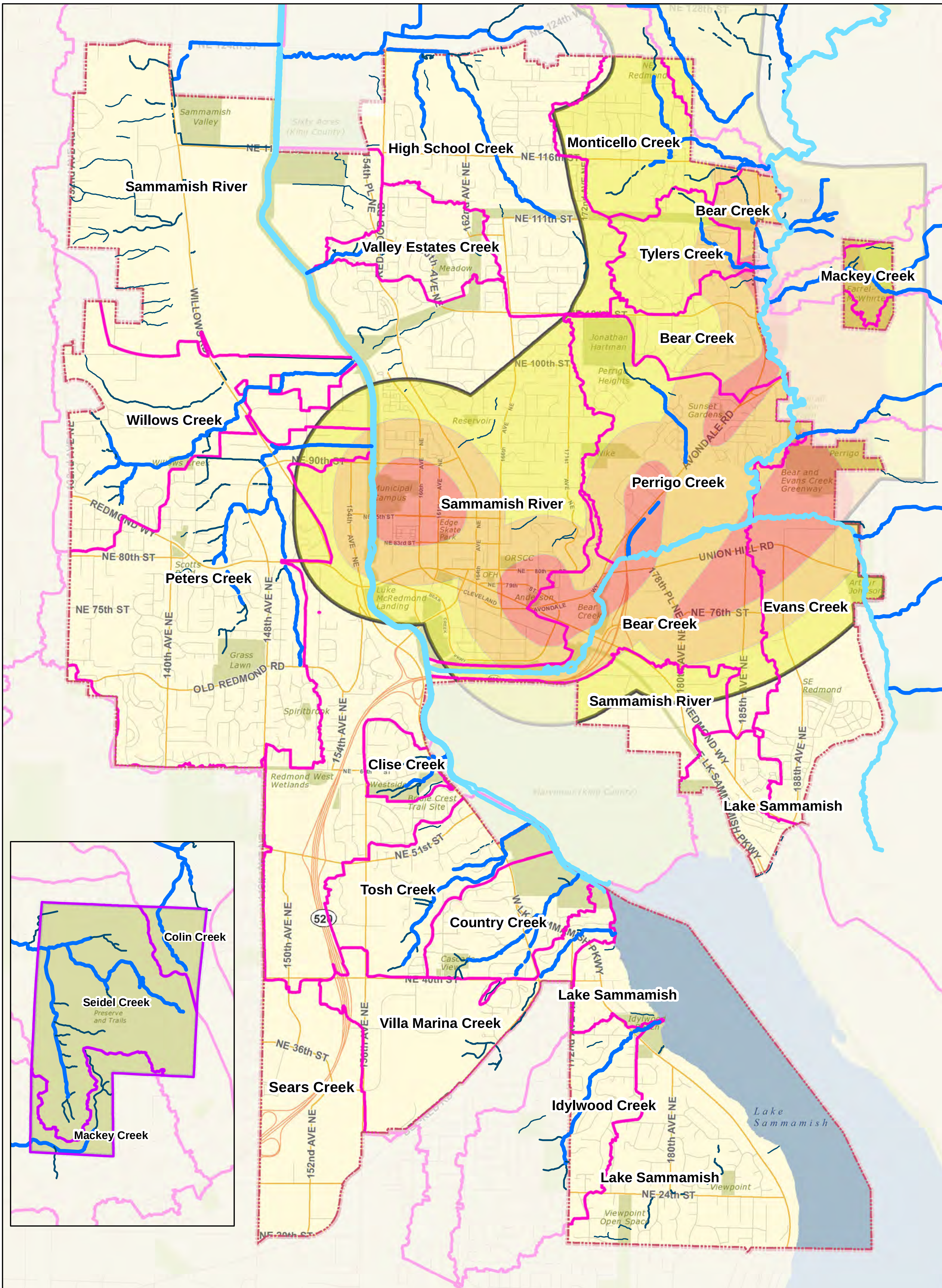

Figure 3.8 - Wellhead Protection Zones in the City of Redmond

City of Redmond, Washington
11/22/2013

0 0.25 0.5 1 Miles

City of Redmond WASHINGTON

Disclaimer: This map is created and maintained by the Natural Resources Division of the City of Redmond, Washington, for reference purposes only. The City makes no guarantee as to the accuracy or completeness of the features shown on this map.

Legend

- Class I Stream
- Class II Stream
- Class III Stream
- Class IV Stream
- City Limits
- Watershed Boundary
- Wellhead Protection Zone
- 6 Month Time of Travel
- 1 Year Time of Travel
- 10 Year Time of Travel

Table 3.1. Summary of Existing Watershed, Fish Use, and Water Quality Conditions for Class I Waterbodies.				
	Sammamish River	**Bear Creek**	**Evans Creek**	**Lake Sammamish**
Land Cover				
% Forest [a]	10%	9%	3%	10%
% Pasture [b]	14%	13%	19%	2%
% Landscape [c]	35%	25%	20%	45%
% Effective Impervious Surface [d]	41%	53%	58%	43%
Land Use [e]				
% Commercial	22%	26%	3%	22%
% Industrial	9%	14%	53%	1%
% Roads [f]	14%	17%	7%	15%
% Single-Family Residential [g]	23%	19%	9%	40%
% Multifamily Residential [h]	7%	9%	8%	11%
% Parks and undeveloped land [i]	25%	15%	22%	11%
Physical Parameters				
Watershed Area (Acres inside City Limits) [j]	3139	713	504	651
Total Watershed Area (Acres inside and outside of City Limits) [k]	153,600	32,100	9,800	63,000
Fish Use				
Chinook Salmon [l]	Tier 1: Migratory	Tier 1: Core	Tier 2: Satellite	Tier 1: Migratory
Other Salmonid Use [m]	Yes	Yes	Yes	Yes
Water Quality				
Known Water Quality Impairments [n]	Yes	Yes	Yes	Yes
High Temperature	Yes	Yes	Yes	No
Low Dissolved Oxygen	Yes	Yes	Yes	No
High Fecal Coliform Bacteria Concentration	Yes	Yes	Yes	Yes

Table 3.1 (continued). Summary of Existing Watershed, Fish Use, and Water Quality Conditions for Class I Waterbodies.

	Sammamish River	Bear Creek	Evans Creek	Lake Sammamish
Stormwater Influence				
% Effective Impervious Surfaces [o]	41%	53%	58%	43%
% High AADT Right-of-way [p]	3%	4%	< 1%	1%
% Watershed Inside Redmond Needing Flow Control Retrofit [q]	19%	76%	70%	38%
% Watershed Inside Redmond Needing Basic WQ Treatment Retrofit [r]	61%	54%	76%	85%

AADT = Annual average daily traffic

[a] Forested areas were delineated using aerial photography by NHC (2006), and updated based on 2010 aerials by City of Redmond.

[b] Pasture areas were delineated using aerial photography by NHC (2006), and updated based on 2010 aerials by City of Redmond.

[c] Landscape is the area in developed watersheds that is not effective impervious. Developed areas (all areas not pasture or forest) were identified as effective impervious or landscaped based on literature values for each land use.

[d] Effective Impervious is the area in developed watersheds that is impervious and directly connected to the storm drain system. Developed areas (all areas not pasture or forest) were identified as effective impervious or landscaped based on literature values for each land use.

[e] Land use designations are parcel based and calculated by summing different land use types into the categories presented from a maintained City of Redmond Land Use GIS database. Function and structure code combinations were used for each land use type.

[f] Roads include the right-of-way parcel, private, and public roads.

[g] Single-family is further differentiated by development density. To determine the split between effective impervious and landscape, four categories of single-family were developed based on parcel size.

[h] Multifamily includes condos and apartments. Commercial first story with dwelling units above are included in commercial area calculation.

[i] Undeveloped land includes areas that are forest and pasture as well as other areas that are not developed.

[j] Includes stormwater conveyance and topographic based watershed.

[k] King County data used outside city limits.

[l] Chinook spawning, rearing and migration taken from the Chinook Conservation Plan (LWCS/WRIA 8 2005).

[m] WDFW (2011 and 2013) and Mobrand Biometrics, Inc. (2003).

[n] Waterbody is identified on the Ecology 303(d) list as a Category 5 or Category 4B (see *Chapter 2: Regulatory Drivers*) due to impairment from the indicated water quality parameters.

[o] Same value as presented in land use section and presented here for easy reference.

[p] Redmond traffic count data used to select right-of-ways where average annual daily traffic (AADT) is 7,500 or greater.

[q] Percentage was calculated using the entire watershed area within Redmond minus areas that are currently forest, flow control exempt, or areas contributing runoff to a flow control facility designed to attenuate flows to match forested hydrology from 1/2 the 2-year through the 50-year storm event.

[r] Percentage was calculated using the entire watershed area within Redmond minus areas that currently contributing runoff to a basic treatment facility or are currently forest or pasture.

- **Percent of Watershed Inside Redmond Needing Flow Control Retrofit** — These are watershed areas without adequate flow control.
- **Percent of Watershed Inside Redmond Needing Basic Water Quality Treatment Retrofit** — These are watershed areas without adequate runoff treatment.

The location of the City's Class I stream watersheds are shown in Figure 3.9 and existing conditions for each stream are summarized in the sections below. Information on Class II streams is summarized in the next subsection.

3.5.1.1 Sammamish River

The Sammamish River watershed covers approximately 100 square miles from its upstream limit at the Lake Sammamish outlet. The areas that drain directly to the Sammamish River within the City are shown in Figure 3.10. The Sammamish River historically meandered for approximately 30 miles between Lake Sammamish and Lake Washington. Construction of the Lake Washington Ship canal, river straightening, bank hardening, drainage and filling of valley wetlands, and river flood control projects have removed most of its meanders, shortened its overall length to 13.6 miles, and largely restricted high flows to within the confines of the channel banks (Herrera and NHC 2004). Despite these modifications, the river provides important migratory and rearing habitat for salmon (LWCS/WRIA8 2005).

The Sammamish River watershed in the City is highly developed, with 22 percent commercial land use and 23 percent single-family residential. Land cover is 41 percent EIS and 35 percent landscaped areas. The City's SMP established 150-foot buffers (areas of undisturbed vegetation) on each side of the river to protect the integrity, function, and value of the riparian corridor (City of Redmond 2011b). In addition, a 50-foot outer buffer was established north of the Puget Sound Energy right-of-way, for a total buffer width of 200 feet along this reach of the river.

Portions of the Sammamish River within the City are listed as a Category 5 waterbody on the 2008 Section 303(d) list for high fecal coliform bacteria concentrations, high temperature, and low dissolved oxygen concentrations (Ecology 2008c).

As shown in Table 3.1, the Sammamish River is designated migratory Chinook habitat under the CSCP. The key life stages in the river are juvenile rearing and pre-spawning migrants. Given the river's migratory status, the CSCP recommends increasing habitat areas (more pools with adequate shade), increasing habitat diversity, and improving water quality (by lowering water temperatures and increasing dissolved oxygen concentrations) to benefit these life stages (LWCS/WRIA 8 2005). These and other technical recommendations are provided in the earlier Sammamish River Corridor Action Plan, which also recommends increased water conservation measures, acquisition of high-value habitats or areas with high potential for restoration, and reduction of unauthorized water withdrawals (Tetra Tech 2002).

3.5.1.2 Bear Creek

Bear Creek is entirely a lowland stream system, originating in a large area of forests and wetlands in south Snohomish County and north King County. The watershed for Bear Creek within the City is shown in Figure 3.11. The Bear Creek watershed represents one of the most important salmonid bearing system in the entire Sammamish River watershed. The Bear Creek watershed covers approximately 32,100 acres (50 square miles). Bear Creek is a right bank tributary of the Sammamish River. With the headwaters located in protected land, Upper Bear Creek has a relatively high level of watershed function resulting from a low impervious surface percentage, few street crossings, and a high level of forest cover and riparian forest. Lower Bear Creek has a moderate level of watershed function, due primarily to higher impervious surface percentage and consequent stormwater impacts, from both poorer water quality and inadequate flow control.

Land use in the Bear Creek drainage within the city limits is highly urbanized with 26 percent of the land used for commercial development. Open space (primarily agriculture) makes up 15 percent of the land use.

A portion of Bear Creek is listed as a Category 4A waterbody for high fecal coliform bacteria concentrations, high temperature, and low dissolved oxygen concentrations (Ecology 2008c). As described in *Chapter 2: Regulatory Drivers*, this category means that a characteristic use is impaired by these pollutants; however, TMDL studies (Ecology 2008a, 2008b) and a water quality implementation plan (Ecology 2011b) addressing these sources of impairment has already been developed and approved by the U.S. EPA.

The headwaters of Bear Creek have wide riparian buffers; however, in the lower reaches there is much less forested riparian buffer (LWCS/WRIA8 2005). In many reaches, woody vegetation has been totally cleared right up to the stream edge and development has occurred within the regulatory buffer (Kerwin 2001). Pursuant to the City’s SMP, buffers of 150 feet are required on either side of Bear Creek west of Avondale Road, and an additional 50-foot outer buffer is required east of Avondale Road.

As shown in Table 3.1, lower Bear Creek is a core Chinook habitat subarea under the CSCP. With this designation, protection of existing high-quality habitat and habitat-forming processes is the primary objective. The CSCP also includes technical recommendations such as protecting water quality and riparian corridors, providing habitat connectivity, and maintaining adequate stream flows (LWCS/WRIA8 2005).The Sammamish River Corridor Action Plan recommends those same strategies as well as increasing water conservation measures in the Bear Creek watershed (Tetra Tech 2002).

3.5.1.3 Evans Creek

Evans Creek is a left bank tributary of Bear Creek in southeast Redmond with headwaters in King County. The upper tributary valley of Evans Creek is characterized by steep-sided walls; lower Evans Creek valley is more similar to the lower gradient Bear Creek valley (Ecology 2008a). However, Evans Creek is characterized by extensive riparian wetlands in its lower and middle reaches while Bear Creek is not.

Within the City’s portion of the watershed (Figure 3.12), land use is primarily industrial with EIS of 53 percent.

Portions of Evans Creek are listed as a Category 4A waterbody for high fecal coliform bacteria concentrations, high temperature, and low dissolved oxygen concentrations (Ecology 2008c). As described in *Chapter 2: Regulatory Drivers*, this category means that a characteristic use

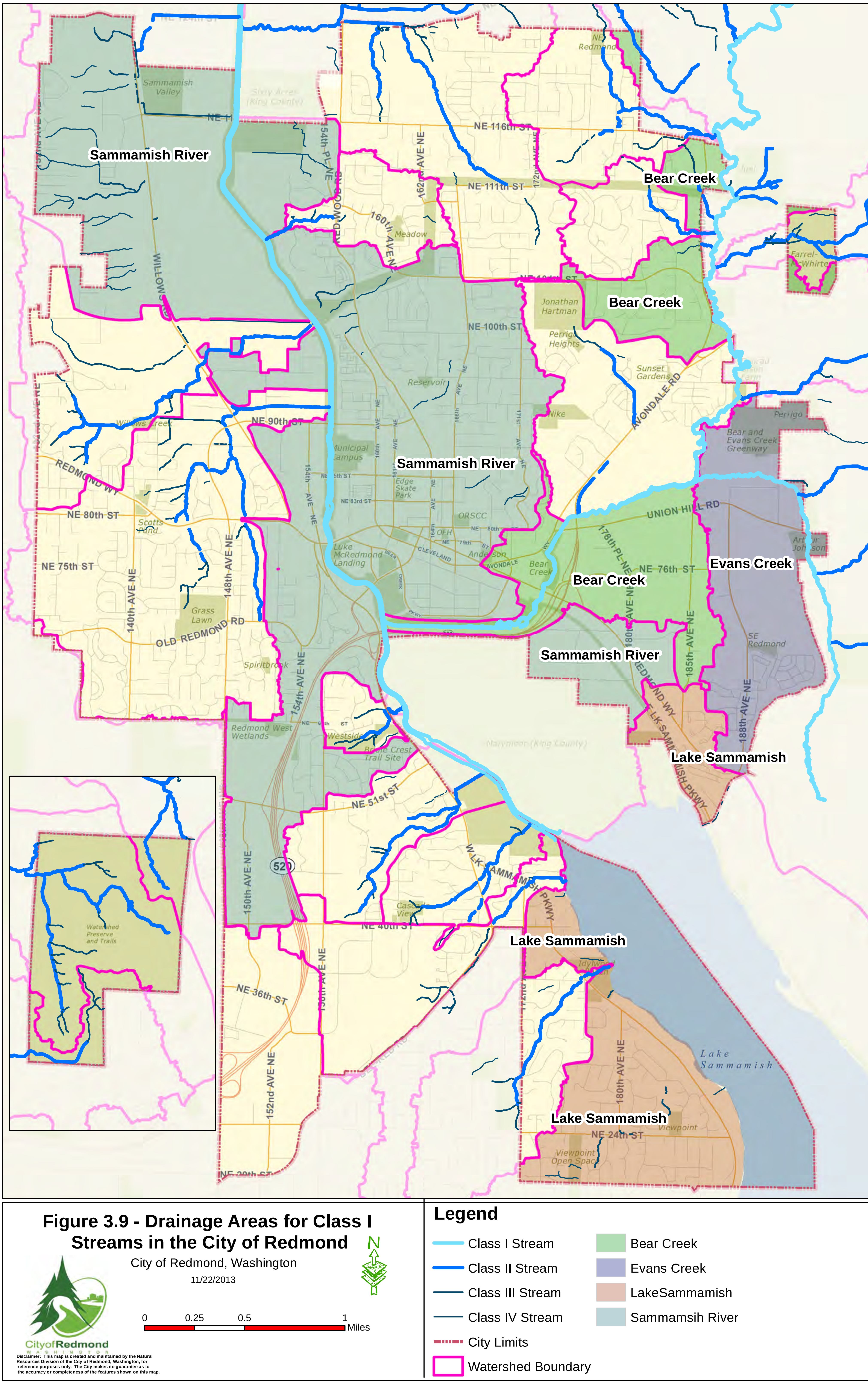

Figure 3.9 - Drainage Areas for Class I Streams in the City of Redmond

City of Redmond, Washington

11/22/2013

City of Redmond WASHINGTON

Disclaimer: This map is created and maintained by the Natural Resources Division of the City of Redmond, Washington, for reference purposes only. The City makes no guarantee as to the accuracy or completeness of the features shown on this map.

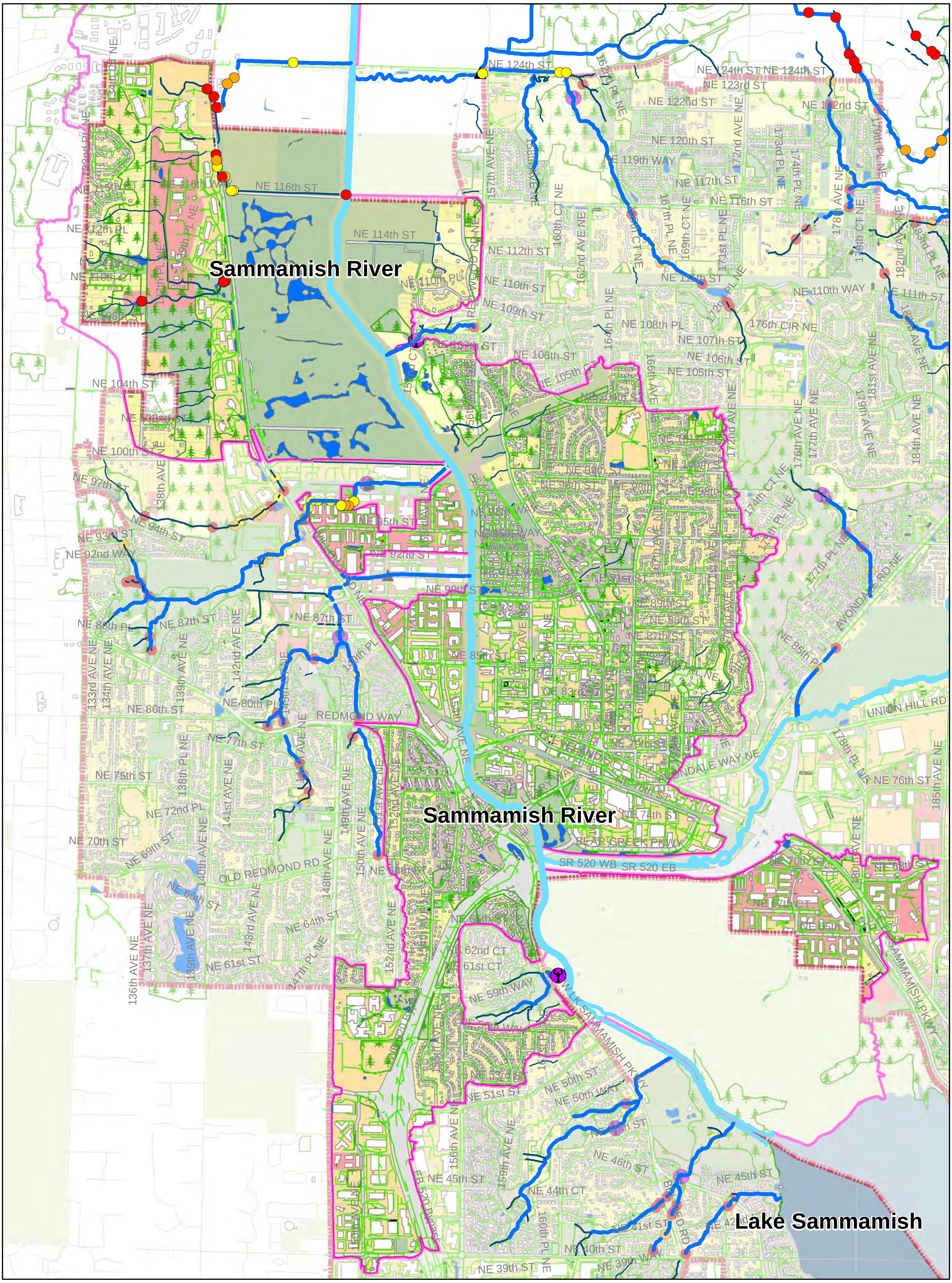

Figure 3.10 - Existing Watershed Conditions For Sammamish River

City of Redmond, Washington

11/22/2013

N

0 0.25 0.5 1 Miles

City of Redmond WASHINGTON

Disclaimer: This map is created and maintained by the Natural Resources Division of the City of Redmond, Washington, for reference purposes only. The City makes no guarantee as to the accuracy or completeness of the features shown on this map.

Legend

- Class I Stream
- Class II Stream
- Class III Stream
- Class IV Stream
- City Limits
- Watershed Boundary
- Ponds
- Stormwater Infrastructure
- Water Quality Monitoring
- Benthic Insect Monitoring
- 0% Passable; Complete Fish Barrier
- 33% Passable; Partial Fish Barrier
- 67% Passable; Partial Fish Barrier
- Forest
- Buildings
- Commercial
- Industrial
- Multifamily
- Park / Undeveloped
- Public ROW
- Single Family HighDensity
- Single Family Low Density
- Single Family Medium Density
- Single Family Rural Density

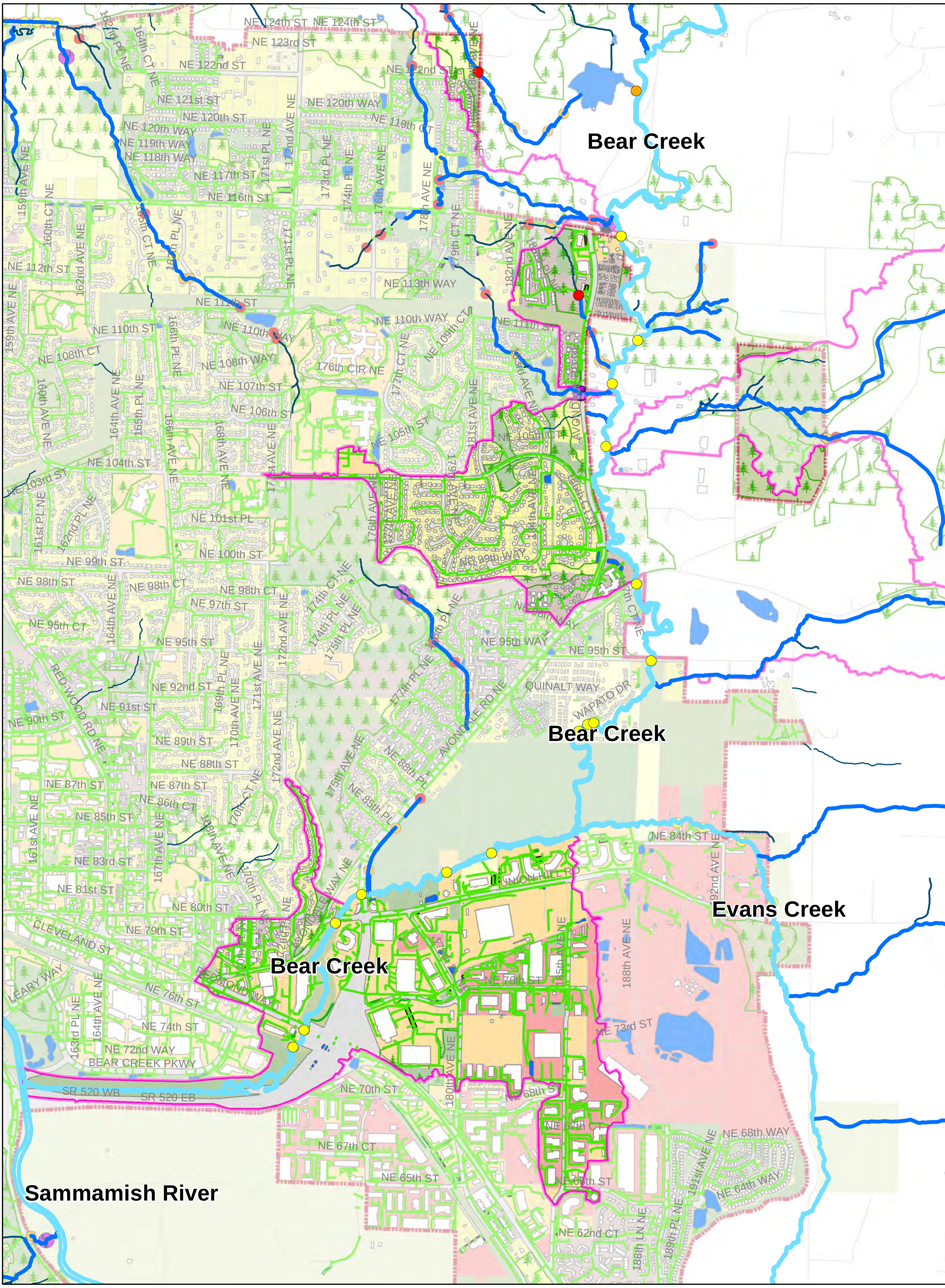

Figure 3.11 - Existing Watershed Conditions For Bear Creek

City of Redmond, Washington

11/22/2013

City of Redmond WASHINGTON

0 0.125 0.25 0.5 Miles

N

Legend

Class I Stream	Water Quality Monitoring	Commercial	Single Family HighDensity
Class II Stream	Benthic Insect Monitoring	Industrial	Single Family Low Density
Class III Stream	0% Passable; Complete Fish Barrier	Multifamily	Single Family Medium Density
Class IV Stream	33% Passable; Partial Fish Barrier	Park / Undeveloped	Single Family Rural Density
City Limits	67% Passable; Partial Fish Barrier	Public ROW	
Watershed Boundary	Forest		
Stormwater Infrastructure	Buildings		
Ponds			

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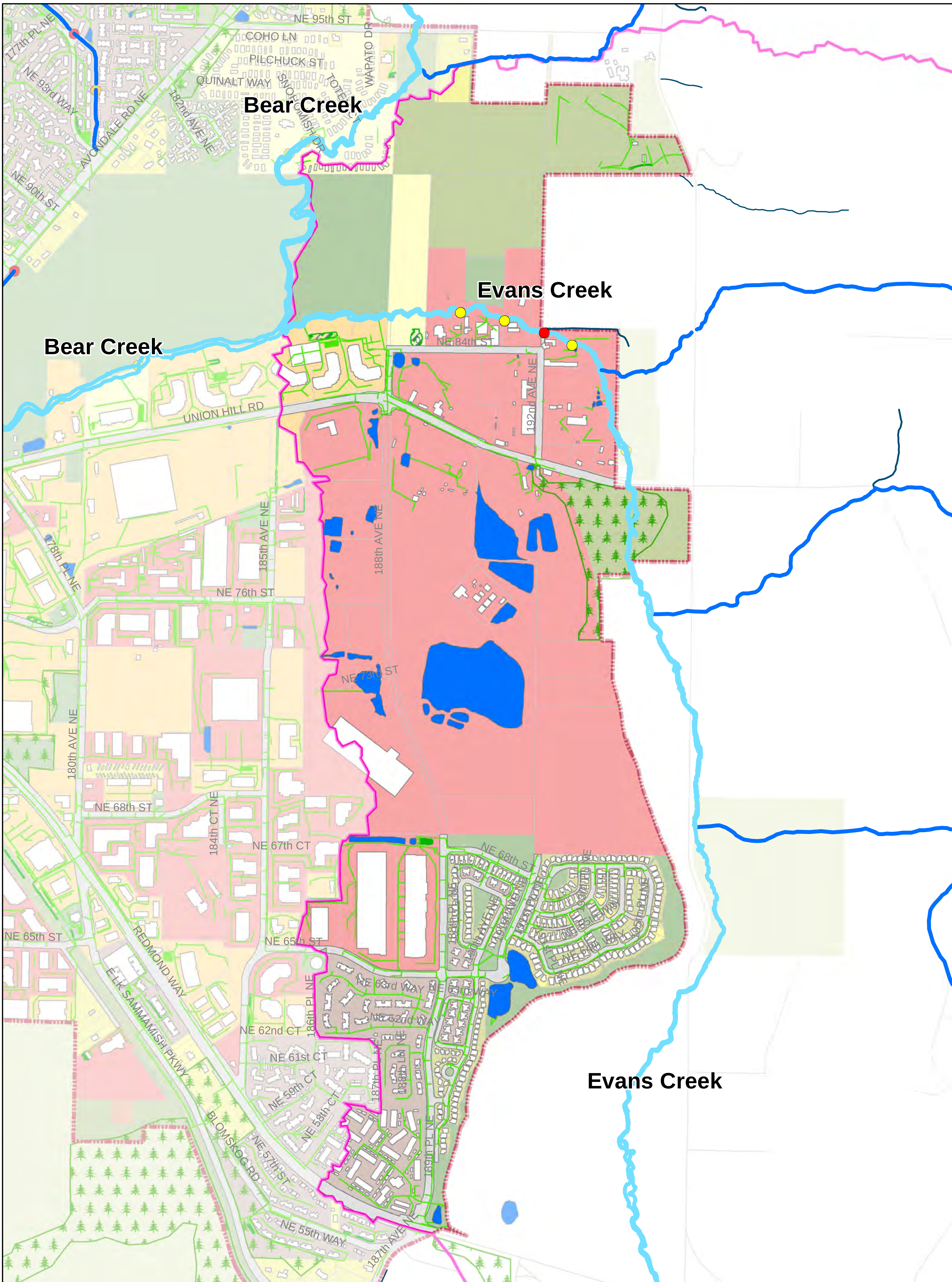

Figure 3.12 - Existing Watershed Conditions For Evans Creek

City of Redmond, Washington

11/22/2013

0 0.1 0.2 0.4 Miles

N

City of Redmond WASHINGTON

Disclaimer: This map is created and maintained by the Natural Resources Division of the City of Redmond, Washington, for reference purposes only. The City makes no guarantee as to the accuracy or completeness of the features shown on this map.

Legend

- Class I Stream
- Class II Stream
- Class III Stream
- Class IV Stream
- City Limits
- Watershed Boundary
- Ponds
- Stormwater Infrastructure
- Water Quality Monitoring
- Benthic Insect Monitoring
- 0% Passable; Complete Fish Barrier
- 33% Passable; Partial Fish Barrier
- 67% Passable; Partial Fish Barrier
- Forest
- Buildings
- Commercial
- Industrial
- Multifamily
- Park / Undeveloped
- Public ROW
- Single Family HighDensity
- Single Family Low Density
- Single Family Medium Density
- Single Family Rural Density

is impaired by these pollutants; however, TMDL studies (Ecology 2008a, 2008b), and a water quality implementation plan (Ecology 2011b) addressing these sources of impairment has already been developed and approved by the U.S. EPA (Ecology 2008a, 2008b).

The watershed function is rated high in the drainage as a whole due to relatively intact wetland, forest, and riparian areas outside the City. However, within the city limits the buffers are either non-existent or highly impacted by industrial land uses that flank the creek. Pursuant to City of Redmond Zoning Code 20D.140.20-020, buffers of 150 feet are required on either side of the stream plus an additional 50-foot outer buffer (City of Redmond 2011b). Other areas of the City drain to portions of the creek outside the City limits where the stream buffer is relatively intact.

Evans Creek is a Chinook salmon satellite area with moderate Chinook abundance and moderately frequent use (LWCS/WRIA8 2005). With this designation, the primary recommendations of the CSCP focus on protection of intact habitat processes and structures by protection of water quality, flows, habitat quality, and habitat attributes. Evans Creek is also characterized by significant coho salmon production.

3.5.1.4 Lake Sammamish

Lake Sammamish forms part of the City's southern boundary. The Lake Sammamish watershed that lies within the City limits includes 504 acres of land (Figure 3.13). The City limits surround, but do not include, King County's 640-acre Marymoor Park which extends northeast from the shoreline of Lake Sammamish. Representing less than 1 percent of the approximately 63,000-acre Lake Sammamish watershed, the portion of the watershed within the City limits is predominantly comprised of single-family residential land use (40 percent) with land cover that is mostly landscaped (45 percent). Therefore, the condition of the lake is overwhelmingly influenced by land use and management practices that are outside of the City's jurisdiction. Pursuant to provisions of the SMA that are described in *Chapter 2: Regulatory Driver*s, Lake Sammamish is designated a Shoreline of Statewide Significance and is therefore a Class I waterbody.

Lake Sammamish is included on Ecology's 2008 Section 303(d) list as a Category 5 waterbody due to impairment from fecal coliform bacteria, dissolved oxygen, and PCBs in tissue (Ecology 2008c). However, in the north end of the lake near the City, it is only listed for fecal coliform bacteria. In general, the lake is designated mesotrophic overall with water quality that varies from good to moderate based on monitoring data and trophic state index scores collected by King County in 2009.

3.5.2 Class II Waterbodies

All of the City's Class II waterbodies are streams. These 16 streams generally have their headwaters in springs and seeps in the uplands of the City to the east and west, then flow through steep wooded ravines down into Lake Sammamish or the wide, flat valleys of the Sammamish River, Bear Creek, or Evans Creek. Gradients are less than 4 percent in the valleys and over 16 percent in many of the ravines.

Pursuant to surface water quality standards for Washington State (WAC 173-201A), all of the Class II streams shall be maintained to support the following designated uses: salmonid spawning, rearing, and migration; primary contact recreation; domestic, industrial, and agricultural water supply; stock watering; wildlife habitat; harvesting; commerce and navigation; boating; and aesthetic values.

Table 3.2 presents general information on physical characteristics, land use and land cover in each stream's watershed within the City. It also presents data on the indicators of habitat integrity or impairment that were summarized above for Table 3.1, plus the following additional indicators that are relevant for Class II streams:

- **Large woody debris** — presence of large woody debris in streams is an important indicator of habitat quality
- **Stream buffer characteristics** — a set of indicators for adequate vegetation cover in the riparian zone
- **Benthic Index of Biotic Integrity (B-IBI) score** — a quantitative method for determining and comparing the biological condition of streams using macro-invertebrate assemblages as indicators. B-IBI data have been collected from the City's streams by the City (ongoing) and King County (2002 to 2010)
- **Number and density of stormwater outfalls and ditches** — an indicator of stormwater impacts on the stream
- **Number of culvert crossing per 1,000 linear feet** — an indicator of stormwater impacts on the stream

The location of the City's Class II stream watersheds are shown in Figure 3.14 and existing watershed, fish use, habitat, and water quality conditions in these watersheds are summarized in the following sections, presented in alphabetical order by stream name.

3.5.2.1 Clise Creek

Clise Creek is a tributary of the Sammamish River that enters the left bank of the Sammamish River in Marymoor Park, King County. The south fork of Clise Creek flows through the forested Westside Neighborhood Park. This fork has numerous seeps and small tributaries, with no direct stormwater sources. The north fork of Clise Creek flows through residential neighborhoods and is subject to flashy flows from stormwater discharges. The two forks join just upstream of West Lake Sammamish Parkway (WLSP), where a ditched section parallels the roadway and the City boundary. The short reach within Marymoor Park has been rehabilitated and contains fairly good salmonid habitat, with a series of weirs providing fish passage to the river. The total stream length is 5,388 feet, of which 4,815 feet are located within the City. The total Class II stream length is 1,808 feet, of which 1,260 feet are located within the City. An average of 3.2 stormwater outfalls can be found per 1,000 feet along the creek.

Figure 3.13 - Existing Watershed Conditions For Lake Sammamish

City of Redmond, Washington

11/22/2013

0 0.1 0.2 0.4 Miles

Legend

- Class I Stream
- Class II Stream
- Class III Stream
- Class IV Stream
- City Limits
- Watershed Boundary
- Ponds
- Stormwater Infrastructure
- Water Quality Monitoring
- Benthic Insect Monitoring
- 0% Passable; Complete Fish Barrier
- 33% Passable; Partial Fish Barrier
- 67% Passable; Partial Fish Barrier
- Forest
- Buildings
- Commercial
- Industrial
- Multifamily
- Park / Undeveloped
- Public ROW
- Single Family HighDensity
- Single Family Low Density
- Single Family Medium Density
- Single Family Rural Density

Table 3.2. Summary of Existing Watershed, Fish Use, and Water Quality Conditions for Class II Streams.

	Clise	Colin	Country	High School	Idylwood	Mackey	Monticello	Perrigo	Peters	Sears	Seidel	Tosh	Tyler's	Valley Estates	Villa Marina	Willows
Land Cover																
% Forest [a]	32%	100%	22%	20%	16%	90%	17%	26%	9%	< 1%	99%	15%	11%	8%	15%	28%
% Pasture [b]	0%	0%	14%	10%	1%	9%	17%	23%	1%	< 1%	1%	6%	11%	7%	0%	14%
% Landscape [c]	41%	0%	42%	43%	51%	1%	42%	29%	48%	15%	0%	39%	43%	50%	21%	32%
% Effective Impervious Surface [d]	26%	0%	22%	27%	32%	0%	23%	22%	42%	84%	0%	39%	35%	35%	64%	26%
Land Use [e]																
% Commercial	0%	0%	0%	11%	2%	0%	4%	3%	5%	75%	0%	15%	17%	8%	64%	15%
% Industrial	0%	0%	0%	0%	0%	0%	0%	0%	8%	0%	0%	0%	0%	0%	0%	8%
% Roads [f]	15%	0%	14%	14%	20%	0%	14%	7%	17%	22%	0%	10%	14%	19%	11%	6%
% Single-Family Residential [g]	48%	0%	42%	62%	59%	0%	63%	24%	46%	1%	0%	38%	43%	62%	5%	36%
% Multifamily Residential [h]	0%	0%	10%	0%	1%	0%	2%	24%	15%	2%	0%	23%	1%	0%	14%	0%
% Parks and undeveloped land [i]	36%	100%	33%	12%	19%	100%	17%	42%	8%	< 1%	100%	13%	26%	11%	6%	35%
Physical Parameters																
Watershed Area (Acres inside City Limits) [j]	73	90	212	635	152	172	264	503	1,007	364	615	276	167	172	365	453
Total Watershed Area (Acres inside and outside of City Limits) [k]	78	1,990	212	1,686	426	1,138	345	509	1,045	10,870	1,188	299	168	172	589	453
Total Stream Length In City (feet) [l]	4,815	2,260	7,210	14,650	4,330	10,230	6,125	5,455	21,325	0	22,220	10,370	2,990	3,135	3,920	13,040
Class II Stream Length In City (feet) [l]	1,260	2,260	5,000	8,505	3,920	4,920	3,170	4,280	12,250	0	13,260	7,215	2,020	2,010	2,470	9,835
Total Stream Length (feet) [m]	5,388	29,265	7,210	34,346	8,067	27,040	9,878	5,455	21,325	1,877	31,121	10,370	3,417	3,135	5,257	13,040
Class II Stream Length (feet) [m]	1,808	25,228	5,000	23,763	4,732	17,897	6,005	4,280	12,250	1,877	19,540	7,215	2,449	2,010	2,470	9,835
Fish Use																
Significant Salmonid Use (y/n) [n]	Yes	Yes	No	Yes	No	Yes	Yes	No	No	NS	Yes	Yes	No	No	No	No
Chinook Salmon (Washington Trout 2004 and 2005)	No	NS	No	No	No	NS	No	No	No	NS	No	No	No	No	No	No
Coho Use (Washington Trout 2004 and 2005)	Yes	NS	No	No	No	NS	Yes	No	Yes	NS	Yes	Yes	Yes	No	No	Yes
Other Salmonid Use (Observed by Redmond Staff)	Yes	Yes	No	Yes	Yes	Yes	Yes	Yes	Yes	No	Yes	Yes	Yes	Yes	Yes	Yes
Habitat																
Large Woody Debris / 100 LF [o]	7.7	15	2.5	4.4	9.2	15	4.4	0.7	3.6	NA	15	3.2	1.6	1.4	3.3	3.8
Tree Canopy % Cover in Buffers [p]	80	97	69	67	56	82	46	36	57	NA	83	69	55	68	53	59
300-foot Buffer % Vegetated [q]	71%	99%	42%	57%	15%	84%	49%	21%	27%	NA	97%	43%	29%	43%	12%	53%
100-foot Buffer % Vegetated [q]	80%	100%	59%	78%	46%	89%	70%	22%	55%	NA	97%	74%	56%	80%	34%	69%
Water Quality																
Benthic Index of Biotic Integrity (B-IBI) [r]	28/Fair	28/Fair	20/Poor	24/Poor	20/Poor	38/Good	36/Fair	32/Fair	20/Poor	No Data	32/Fair	19/Poor	20/Poor	18/Poor	19/Poor	22/Poor
Known Water Quality Impairments [s]	Yes	No Data	Yes	Yes	Yes	Yes	Yes	Yes	Yes	No Data	No Data	Yes	Yes	Yes	Yes	Yes
High Temperature	No	No Data	No	No	Yes	Yes	Yes	Yes	No	No Data	No Data	No	Yes	No	Yes	Yes
Low Dissolved Oxygen	No	No Data	No	No	Yes	Yes	No	No	No	No Data	No Data	No	No	No	Yes	Yes
High Fecal Coliform Bacteria Concentration	Yes	No Data	Yes	Yes	Yes	No	Yes	No	Yes	No Data	No Data	Yes	No	Yes	Yes	Yes

Table 3.2 (continued). Summary of Existing Watershed, Fish Use, and Water Quality Conditions for Class II Streams.																
	Clise	Colin	Country	High School	Idylwood	Mackey	Monticello	Perrigo	Peters	Sears	Seidel	Tosh	Tyler's	Valley Estates	Villa Marina	Willows
Stormwater Influence																
% Effective Impervious Surfaces [t]	26%	0%	22%	27%	32%	0%	23%	22%	42%	84%	0%	39%	35%	35%	64%	26%
% High AADT Right-of-way [u]	1.5%	0.0%	2.2%	1.7%	0.6%	0.0%	1.8%	1.4%	2.8%	5%	0.0%	**1.4%**	0.0%	1.2%	2.8%	1.0%
% Watershed Inside Redmond Needing Flow Control Retrofit [v]	36%	100%	38%	24%	18%	96%	30%	57%	36%	5%	99%	26%	29%	93%	24%	53%
% Watershed Inside Redmond Needing Basic WQ Treatment Retrofit [w]	33%	100%	45%	62%	20%	99%	73%	61%	29%	30%	100%	26%	85%	20%	43%	67%
# of Outfalls and Ditches [x]	4	0	12	11	11	0	11	16	23	0	6	6	6	5	9	4
# of Outfalls and Ditches/1,000 LF [y]	4.0	0.0	3.0	1.6	2.8	0.0	3.8	4.9	3.8	0.0	1.2	3.0	3.0	4.9	1.1	4.0
# of Culvert Crossings/1,000 LF Class II [z]	0.8	0.0	1.6	1.2	0.8	0.2	0.9	1.9	1.1	NA	0.0	0.4	1.0	1.0	1.2	1.2
# of Mapped Ditch Outfalls (or Pipes Smaller Than 12") Potentially Draining From Pollution Generating Surfaces within City Limits	1	0	3	3	0	0	1	5	23	0	3	0	0	7	2	1

AADT = Annual average daily traffic
LF = Linear feet
NA = Not applicable
NS = Not surveyed

[a] Forested areas were delineated using aerial photography by NHC (2006), and updated based on 2010 aerials by City of Redmond.
[b] Pasture areas were delineated using aerial photography by NHC (2006), and updated based on 2010 aerials by City of Redmond.
[c] Landscape is the area in developed watersheds that is not effective impervious. Developed areas (all areas not pasture or forest) were identified as effective impervious or landscaped based on literature values for each land use.
[d] Effective Impervious is the area in developed watersheds that is impervious and directly connected to the storm drain system. Developed areas (all areas not pasture or forest) were identified as effective impervious or landscaped based on literature values for each land use.
[e] Land use designations are parcel based and calculated by summing different land use types into the categories presented from a maintained City of Redmond Land Use GIS database. Function and structure code combinations were used for each land use type.
[f] Roads include the right-of-way parcel, private, and public roads.
[g] Single-family is further differentiated by development density. To determine the split between effective impervious and landscape, four categories of single-family were developed based on parcel size.
[h] Multifamily includes condos and apartments. Commercial first story with dwelling units above are included in commercial area calculation.
[i] Undeveloped land includes areas that are forest and pasture as well as other areas that are not developed.
[j] Includes stormwater conveyance and topographic based watershed.
[k] Total acres of stream area in and outside city limits. King County data was used outside city limits.
[l] Limited to the city limits.
[m] Not limited to the city limits; includes streams in other jurisdictions.
[n] Observed significant salmonid use is greater than 50 fish per 100 linear feet of channel, taken from Washington Trout stream surveys (2004 and 2005) and Redmond staff observations.
[o] Large Woody Debris - wood at least 10 inches in diameter and 10 feet long, in or over bankful channel counted by field crews. Weighted average of LWD density over walked channel length. Values for Colin, Mackey, and Seidel are estimated.
[p] Tree canopy including trees a minimum 10-foot diameter canopy within regulatory buffers (for open channel stream reaches within the city limits). Digitized from 2007 aerial photos.
[q] Higher values –equate to more vegetation. All vegetation excluding landscaped and mowed or plowed land is included - trees, shrubs, and unmowed grasses. Limited to city limits.
[r] Benthic Index of Biotic Integrity (B-IBI) scores provide a quantitative method for determining and comparing the biological condition of streams using macroinvertebrate assemblages as indicators. B-IBI score shown is the median value of all samples taken from the applicable stream. 10-25=poor, 26-37=fair, 38-45=good, 46-50=excellent.
[s] Waterbody is identified on the Ecology 303(d) list as a category 5 or category 4B (see *Chapter 2: Regulatory Drivers*) due to impairment from the indicated water quality parameter.
[t] Same value as presented in land use section (presented here for easy reference).
[u] Redmond traffic count data used to select right-of-ways where AADT is 7,500 or greater.
[v] Percentage was calculated using the entire watershed area within Redmond minus areas that are currently forested, flow control exempt, or areas contributing runoff to a flow control facility designed to attenuate flows to match forested hydrology from 1/2 the 2-year through the 50-year storm event.
[w] Percentage was calculated using the entire watershed area within Redmond minus areas that currently contribute runoff to a basic treatment facility or are currently forest or pasture.
[x] Number of mapped stormwater outfalls or ditches draining pollution generating surfaces that discharge to a stream, for all stream classes within the city limits.
[y] Outfalls and ditches draining pollution generating surfaces per 1,000 LF on all stream classes within the city limits.
[z] Mapped culvert crossings (street, driveway, or utility) per 1,000 LF on mapped Class II stream channels in each watershed within the city limits. Does not include trail bridges, long storm pipes, pipe outfalls, or piped sections of stream headwaters (even if mapped in culvert layer). Multiple parallel culverts are counted as one crossing.

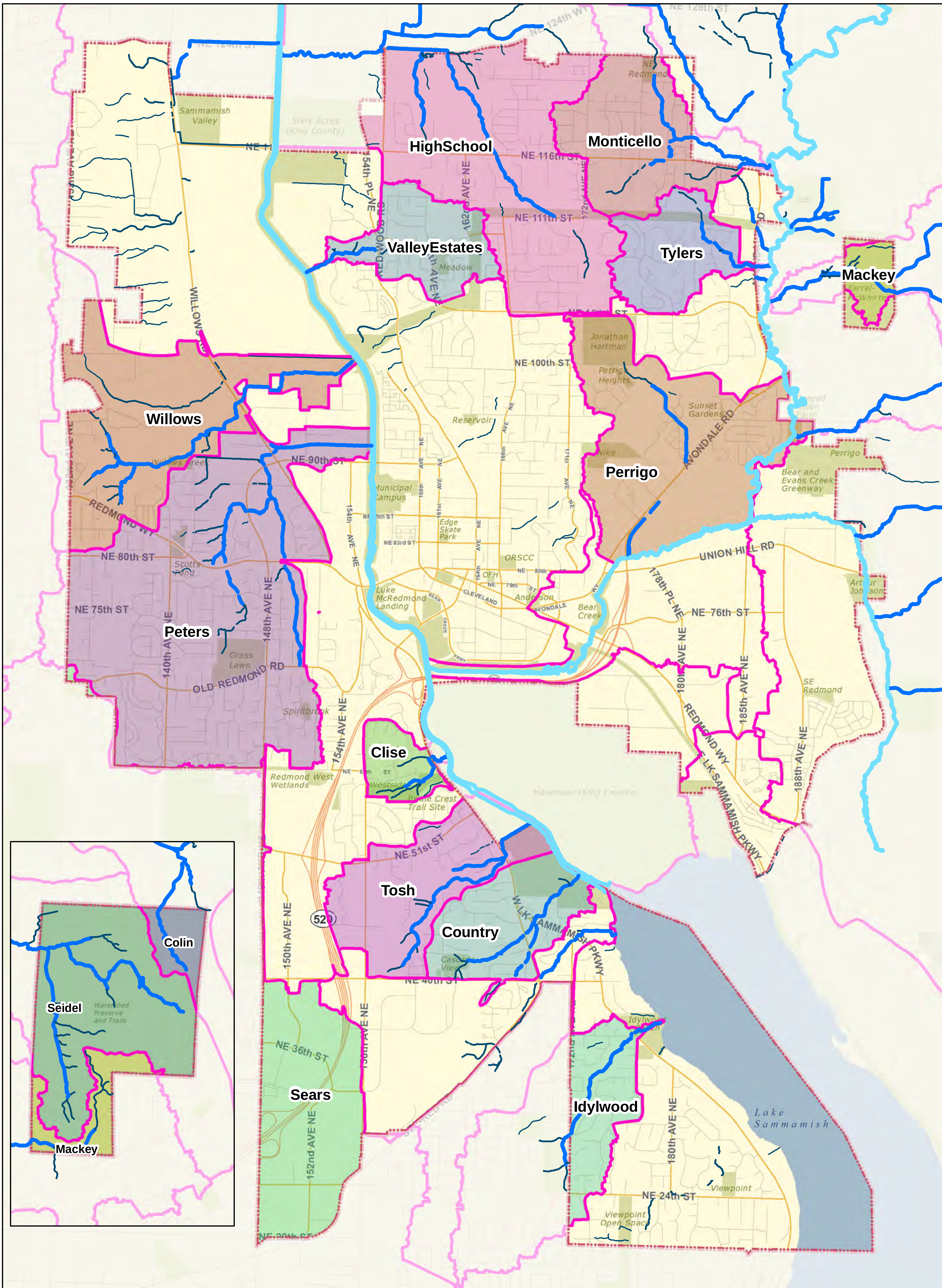

Figure 3.14 - Drainage Areas for Class II Streams in the City of Redmond

City of Redmond, Washington

11/22/2013

0 0.25 0.5 1 Miles

Legend

- Class I Stream
- Class II Stream
- Class III Stream
- Class IV Stream
- City Limits
- Watershed Boundary

Clise	Peters	
Colin	Sears	
Country	Seidel	
HighSchool	Tosh	
Idylwood	Tylers	
Mackey	ValleyEstates	
Monticello	VillaMarina	
Perrigo	Willows	

City of Redmond WASHINGTON

Disclaimer: This map is created and maintained by the Natural Resources Division of the City of Redmond, Washington, for reference purposes only. The City makes no guarantee as to the accuracy or completeness of the features shown on this map.

The portion of the Clise Creek watershed within the City is 73 acres. Land use is predominantly single-family dwellings and parks and undeveloped land (see Figure 3.15). The EIS area within the City's portion of the watershed is 26 percent. Land cover is predominantly landscaped yards and forest (it has the highest forested land cover percentage outside the watersheds containing portions of Redmond Watershed Preserve Park). Stormwater discharges to the stream are limited mostly to the north fork and along WSLP.

Ecology included Clise Creek (previously named Bridlecrest Creek) on the 2008 Section 303(d) list as a Category 5 waterbody due to impairment from fecal coliform bacteria (Ecology 2008c). The median B-IBI score for Clise Creek is 30; indicating fair conditions (PSSB 2011). Significant salmonid use has been observed both downstream and upstream of WLSP (Washington Trout 2005).

Riparian buffers consisting of mature native forests are mostly protected within Westside Neighborhood Park. Large areas of ivy and blackberry in and adjacent to the park have been removed and restored to native plants. The riparian buffers on the north fork of Clise Creek are narrower, impacted by invasive weeds, and surrounded by development that discharges stormwater to the creek. The ditch along WLSP has poor riparian cover.

There remains one partial fish passage barrier at the culvert under WLSP; a full barrier at the confluence with the Sammamish River that has been removed by the City (Figure 3.15).

3.5.2.2 Colin Creek

Colin Creek has its headwaters in the City-owned Redmond Watershed Preserve Park. The Redmond Watershed Preserve Park was purchased in 1926 for a domestic water supply (City of Redmond 2011c). It occupies an 800-acre parcel of land that is outside the City's contiguous limits but within the City's jurisdiction. In addition to Colin Creek, two other creeks within the City (Mackey Creek and Seidel Creek) also have their headwaters in the park. Because the City has prohibited development within the Redmond Watershed Preserve Park, it is considered one of the most pristine lowland forests in King County (Luchetti, personal communication, 2011). Colin Creek flows north out of a large wetland through the Redmond Watershed Preserve Park, enters Welcome Lake, exits the lake over a spillway with a fishway of questionable function, and then enters a steep ravine. Colin Creek then joins Struve Creek, a left bank tributary of Bear Creek. Only 2,260 linear feet, out of a total of 29,265 linear feet, are located within City boundaries. The entire stream within the City is designated as a Class II stream. No stormwater outfalls exist along the creek.

The watershed within the City limits is 90 acres, and is 100 percent comprised of parks and undeveloped land (see Figure 3.16). It consists of dense stands of mature conifer forest, which provide good cover for the stream. The channel has substantial amounts of large woody debris that contribute to a diverse instream habitat.

Colin Creek is not listed on the 2008 Section 303(d) list of threatened and impaired waterbodies (Ecology 2008c). B-IBI sampling was not performed by the City on Colin Creek; however, King County conducted sampling in this watershed from 1997 through 2010. The median B-IBI score for Colin Creek is 28; indicating fair conditions (PSSB 2011).

Dense stands of second generation forest flank both sides of Colin creek as it meanders through the Redmond Watershed Preserve Park, north into unincorporated King County. The riparian zone is one of the most pristine in Redmond with 97 percent forest cover. The system is complex with thick vegetation providing shade for the majority of the channel. Very few invasive species are found within Colin Creek's buffers, or within the portion of its watershed located in Redmond. A large wetland complex is present in the headwaters that feed both Colin and Seidel Creek.

Neither Washington Trout or City crews officially surveyed Colin Creek for fish presence, but there are anecdotal reports of numerous cutthroat trout present. WDFW maps show coho spawning in the reach below Welcome Lake (WDFW 2011). There is one fish passage barrier within the watershed preserve (Figure 3.16).

3.5.2.3 Country Creek

Country Creek is located in the southwest portion of the City. Country Creek enters the Sammamish River near the outlet of Lake Sammamish approximately 1,500 feet upstream of the weir. The lower reach of Country Creek on the valley floor flows through a seasonally flooded and wooded wetland complex that is backwatered from the lake. Closer to WLSP, the stream flows through stands of dense blackberry and reed canarygrass with little native vegetation. Upstream of the valley floor, the channel runs through residential neighborhoods. The headwaters of Country Creek are located in Cascade View Neighborhood Park where several springs feed the modest flow in the upper reach. A right bank tributary enters the stream just upstream of WLSP. The total stream length is 7,210 feet of which 5,000 feet are designated as a Class II stream. An average of 1.6 stormwater outfalls can be found per 1,000 feet along the creek.

The Country Creek watershed consists of 212 acres located entirely within City boundaries. The lower 800 feet of the stream channel flows through King County-owned open space property. Land use is predominantly single-family dwellings (see Figure 3.17). The EIS area in the watershed is 22 percent. Land cover is predominantly landscaped yards.

Country Creek is listed as a Category 5 waterbody on Ecology’s 2008 Section 303(d) list due to impairment from fecal coliform bacteria (Ecology 2008c). The median B-IBI score for Country Creek is 20, indicating poor conditions (PSSB 2011).

Riparian buffers are narrow in the middle reaches near WLSP, but broad in the upper reach with thick vegetation and mature conifers. On average, development encroaches on 17 percent of the 30-foot riparian buffer.

There are 10 fish passage barriers on Country Creek and the right bank tributary; six are complete barriers and four are partial barriers. The undersized culvert under WLSP is a partial barrier. The first complete barrier is on the main stem upstream of the right bank tributary (Figure 3.17). There has been no observed salmonid use in Country Creek based on surveys by Washington Trout crews (Washington Trout 2005), likely due to these multiple barriers.

Figure 3.15 - Existing Watershed Conditions For Clise Creek

City of Redmond, Washington

11/22/2013

CityofRedmond
WASHINGTON

0 125 250 500 Feet

N

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Legend

- Class I Stream
- Class II Stream
- Class III Stream
- Class IV Stream
- City Limits
- Watershed Boundary
- Stormwater Infrastructure
- Water Quality Monitoring
- Benthic Insect Monitoring
- 0% Passable; Complete Fish Barrier
- 33% Passable; Partial Fish Barrier
- 67% Passable; Partial Fish Barrier
- Forest
- Buildings
- Commercial
- Industrial
- Multifamily
- Park / Undeveloped
- Public ROW
- Single Family HighDensity
- Single Family Low Density
- Single Family Medium Density
- Single Family Rural Density

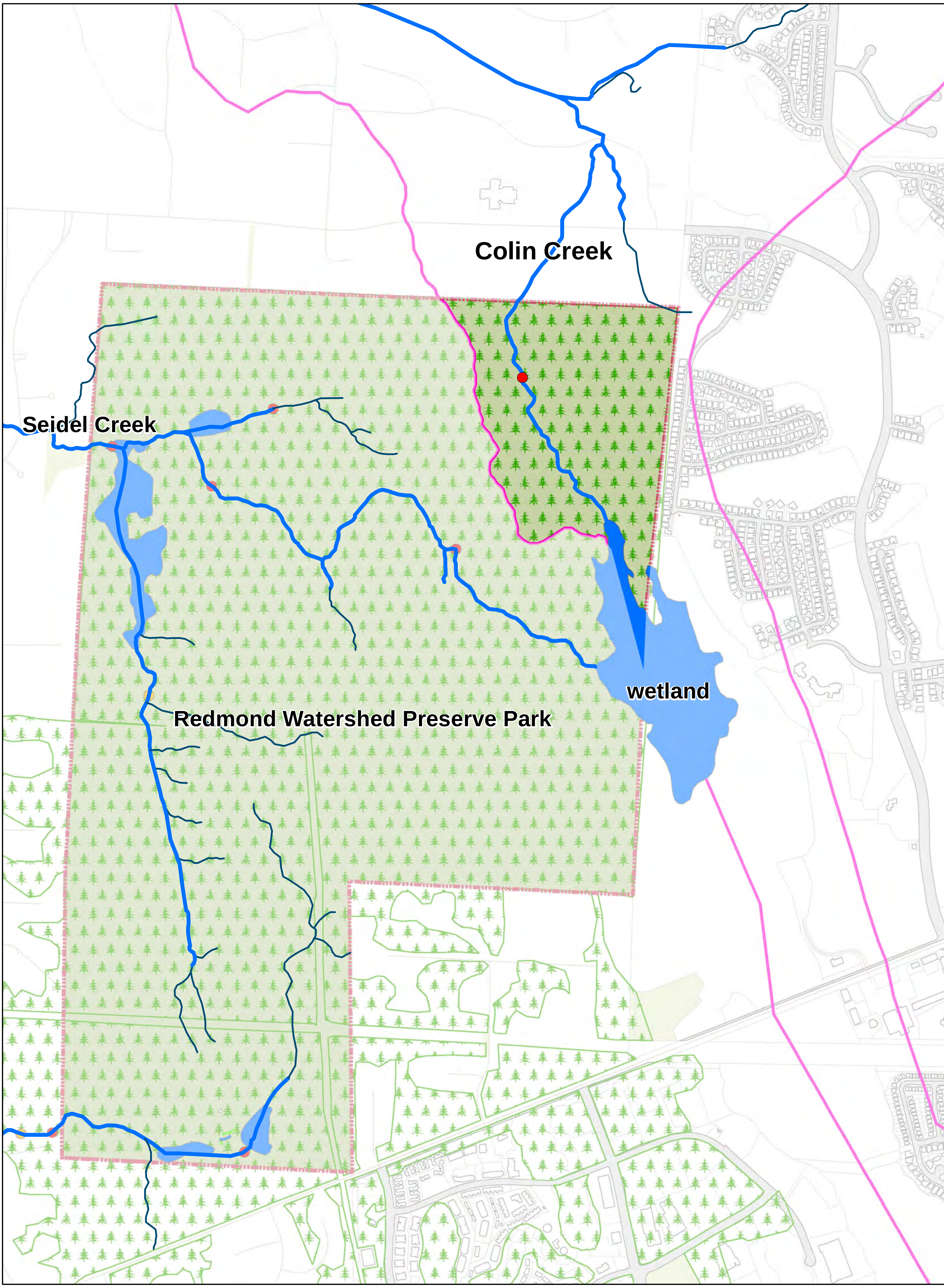

Figure 3.16 - Existing Watershed Conditions For Colin Creek

City of Redmond, Washington
11/22/2013

N

0 0.1 0.2 0.4 Miles

Legend

- Class I Stream
- Class II Stream
- Class III Stream
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- Stormwater Infrastructure
- Ponds
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CityofRedmond
WASHINGTON

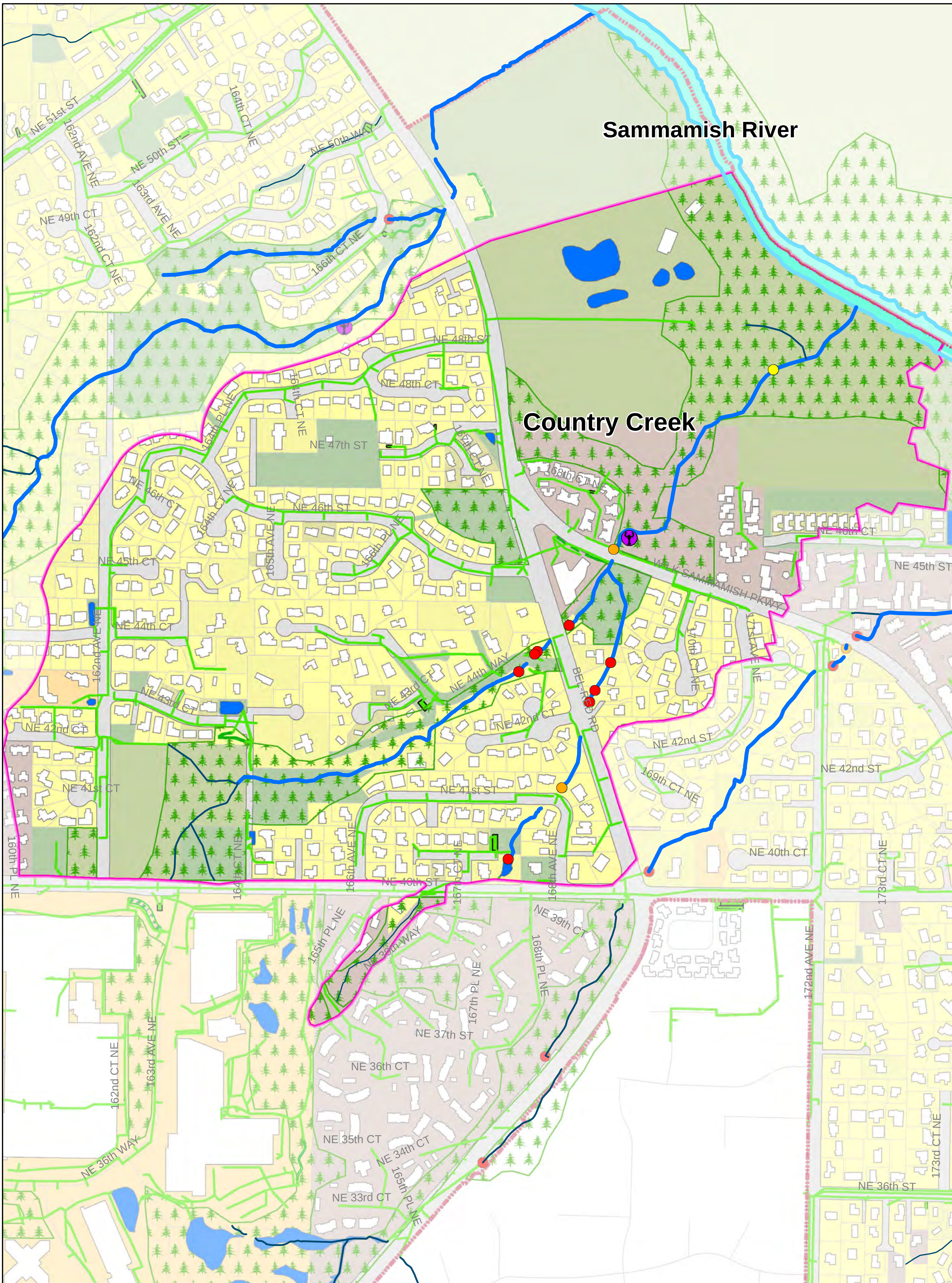

Figure 3.17 - Existing Watershed Conditions For Country Creek

City of Redmond, Washington

11/22/2013

0 250 500 1,000 Feet

City of Redmond WASHINGTON

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3.5.2.4 High School Creek

High School Creek is a right bank tributary of the Sammamish River that is located in the northern portion of the City. A major portion of the upper watershed is located in the City, while the other main tributary as well as the valley portion is located in unincorporated King County. The stream length within the City is 14,650 feet, 8,505 feet of which is designated as a Class II stream. A left bank tributary, Kensington Tributary enters High School Creek near Redmond Woodinville Road.

A King County channel relocation project was recently completed on the downstream reach of this tributary, including a culvert replacement under NE 124th Street and rehabilitation of an adjacent wetland. Upstream of the relocation project, the tributary flows through wetlands in a narrow ravine. The main stem of High School Creek flows through a future development project with a short, highly degraded section of the stream. Upstream of this impacted reach, the stream enters a densely forested ravine with a thick understory. There is a 4-acre manmade pond at the headwaters of High School Creek. Portions of the stream system have been straightened in the residential areas (Washington Trout 2005). An average of 1.2 stormwater outfalls can be found per 1,000 feet along the creek.

The High School Creek watershed is approximately 1,686 acres, of which 635 acres are located in the City. Land use in the City portion of the watershed is predominantly single-family residences, which are characterized by large lots that transition to more dense development (see Figure 3.18). While land cover is mostly landscaping, there are significant areas of established forest buffering the streams along steep ravines. Twenty-seven percent of the watershed within the City is considered EIS.

Ecology included a segment of High School Creek downstream NE 116th Street on the 2008 Section 303(d) list as a Category 5 waterbody due to impairment from fecal coliform bacteria (Ecology 2008c). The median B-IBI score for High School Creek based on data collected by the City as part of the Annual Benthic Monitoring study (2011) is 30, indicating fair conditions (PSSB 2011).

The riparian buffer is in good condition in the channel relocation reach in the valley. The adjacent rehabilitated wetland provides additional buffer. Further upstream, the steep ravine provides a relatively wide riparian buffer of mostly deciduous trees and wetlands with invasive plant species. Near 167th Place NE, the valley becomes less confined and residential development begins to infringe on the riparian buffer (Washington Trout 2005).

There are eight fish passage barriers on High School Creek including seven partial barriers and two complete barriers. One complete barrier (a perched culvert) south of NE 116th Street has been replaced with a fish passable culvert (Figure 3.18). There are additional downstream barriers outside of the city limits. Significant salmonid use has been observed in High School Creek based on Washington Trout surveys (Washington Trout 2005). There are anecdotal reports of coho salmon using the lowest reach and documented cutthroat trout in the reach through the ravine (Washington Trout 2005).

3.5.2.5 Idylwood Creek

Idylwood Creek is located in the southwest portion of the City. It enters Lake Sammamish east of WLSP where the stream flows through Idylwood Park. Upstream of WLSP, the incised creek channel flows through a steep wooded ravine with residential development along the ravine. Ardmore Park, in the City of Bellevue, is located at the headwaters of the creek. The stream length within the City is 4,330 feet, of which 3,920 feet is designated as a Class II stream. The Idylwood channel was rehabilitated in two phases. The first phase was completed in 2002 in Idylwood Park downstream of WLSP. The second phase was completed in 2005, along a longer reach of the creek stretching nearly to the City limits (with the most upstream 1,000 feet a rock lined channel with narrow buffers). The channel rehabilitation was intended to solve problems due to erosion, fish barriers, and lack of instream habitat diversity. Most of the instream work was log and boulder installation, but the rehabilitation projects also included replanting the buffers. A high-flow bypass was also installed to protect the stream channel from erosive flows. The project was designed to bypass high flows around the middle portions of the creek and modified the channel within Idylwood Park to handle the stormwater flows that reenter the stream just east of WLSP. The bypass requires annual maintenance to prevent clogging due to debris and sediment accumulation, and has not always functioned well during large rain events (City of Redmond 2008). There are also several stormwater outfalls discharging to the creek that do not meet current flow control and water quality standards. Finally, high flows and sediment are believed to be entering the stream from Ardmore Park. An average of 0.8 outfalls per 1,000 feet can be found along the creek.

The Idylwood Creek watershed within the City is 152 acres; the entire watershed is 426 acres. It is a highly developed watershed with predominantly single-family dwellings (see Figure 3.19). Approximately 32 percent of the watershed within the City is considered EIS. Land cover is predominantly landscaped yards and residential dwellings.

Ecology included Idylwood Creek from the mouth to the headwaters on the 2008 Section 303(d) list as a Category 5 waterbody due to impairment from low dissolved oxygen and high fecal coliform bacteria concentrations (Ecology 2008c). Idylwood Creek’s mouth is adjacent to the only public swimming beach on Lake Sammamish within the City. High fecal coliform concentrations in water that is discharged to the lake from Idylwood Creek have caused concern in the past, closing the beach to swimming in 2003. Idylwood Creek is also listed as a Category 2 waterbody for temperature impairment and as a Category 1 waterbody for pH. The median B-IBI score for Idylwood Creek based on data collected by the City as part of the Annual Benthic Monitoring study (2002 through 2010) is 20, indicates poor conditions (PSSB 2011).

Riparian buffers are narrow, but well vegetated, and native vegetation is becoming established in the rehabilitated reach within Idylwood Park. Further upstream, the riparian zone is forested with large conifers. The furthest upstream reach in the City is a riprap channel with very narrow buffers planted mostly with alder.

There are four fish passage barriers on Idylwood Creek. Two barriers in the lower watershed are partially passable (67 percent), while the two barriers in the upper watershed near the City boundary are complete barriers (Figure 3.19). There has been no significant salmonid use

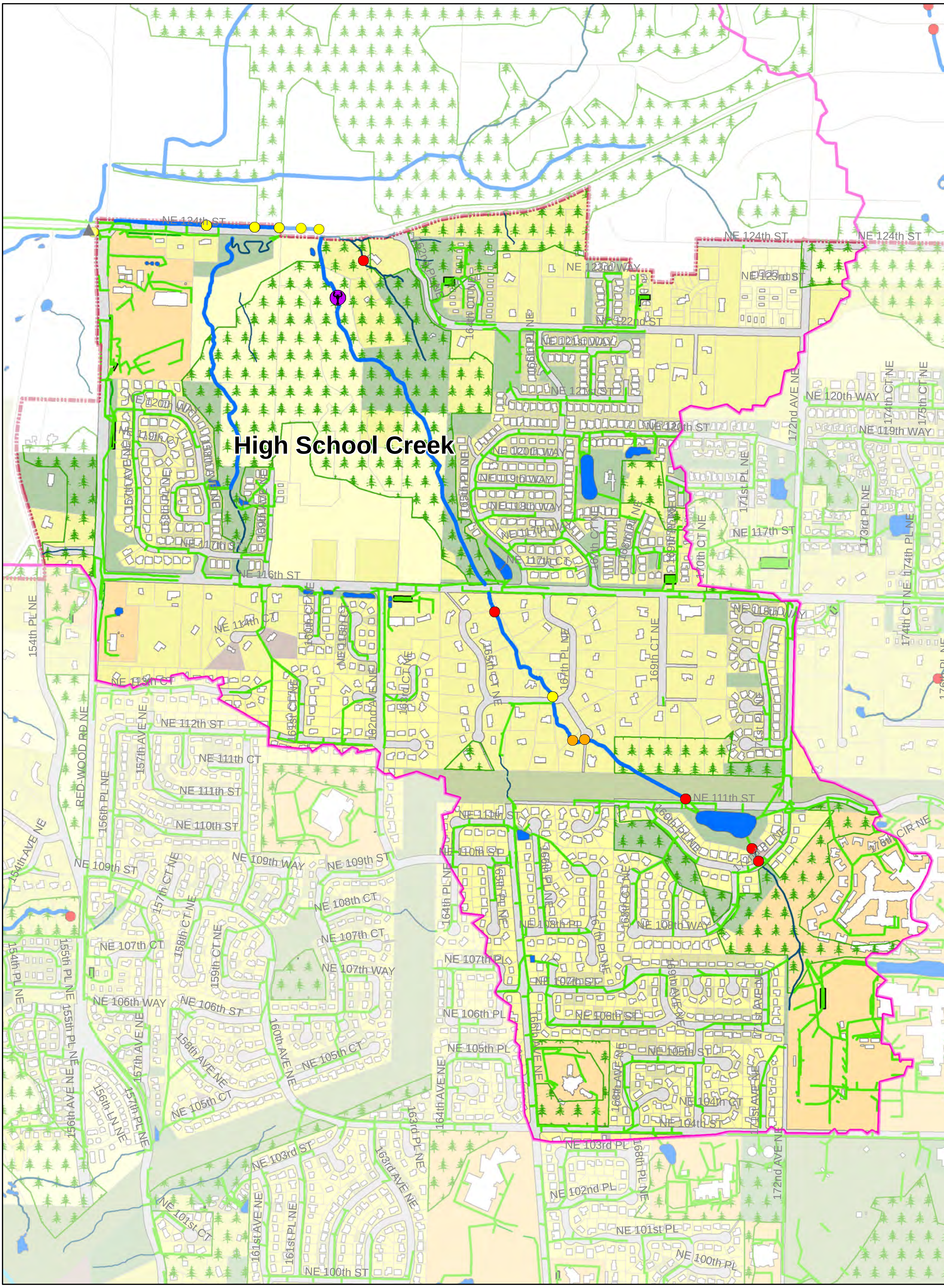

Figure 3.18 - Existing Watershed Conditions For High School Creek

City of Redmond, Washington

11/22/2013

0 0.125 0.25 Miles

N

CityofRedmond WASHINGTON

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Legend

- Class I Stream
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- Ponds
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- Water Quality Monitoring
- Benthic Insect Monitoring
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- 33% Passable; Partial Fish Barrier
- 67% Passable; Partial Fish Barrier
- Forest
- Buildings
- Commercial
- Industrial
- Multifamily
- Park / Undeveloped
- Public ROW
- Single Family HighDensity
- Single Family Low Density
- Single Family Medium Density
- Single Family Rural Density

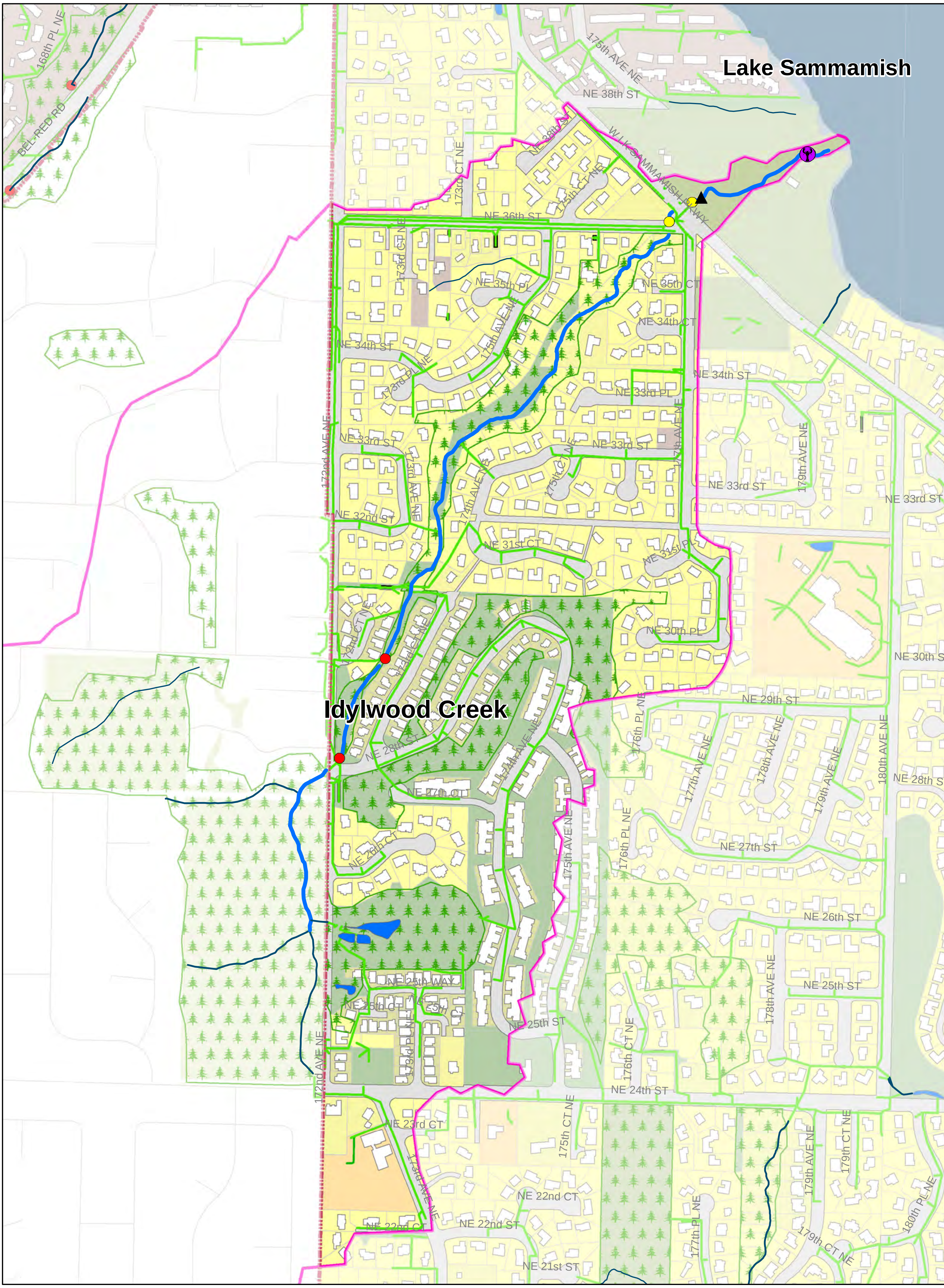

Figure 3.20 - Existing Watershed Conditions For Idylwood Creek

City of Redmond, Washington

11/22/2013

0 0.05 0.1 0.2 Miles

Legend

- Class I Stream
- Class II Stream
- Class III Stream
- Class IV Stream
- City Limits
- Watershed Boundary
- Ponds
- Stormwater Infrastructure
- Water Quality Monitoring
- Benthic Insect Monitoring
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- Single Family Low Density
- Single Family Medium Density
- Single Family Rural Density

observed in Idylwood Creek. Young of the year coho salmon (coho that have hatched during the year of observation) were seen downstream of WLSP during Washington Trout surveys (Washington Trout 2005). Fish were observed upstream of WLSP after weirs were installed (Reitemeyer, personal communication, 2006).

3.5.2.6 Mackey Creek

Mackey Creek is a left bank tributary of Bear Creek. Mackey Creek's watershed includes Farrel-McWhirter Park and a portion of the Redmond Watershed Preserve Park described previously. Both parks are outside the City's contiguous limits but within the City's jurisdiction. Mackey Creek originates in the uplands east of the City and within the Redmond Watershed Preserve Park. After the confluence of two headwater tributaries, Mackey Creek flows through a steep wooded ravine, then through rural King County pastureland, and rural lots before it enters Farrel-McWhirter Park. Downstream of Farrel-McWhirter Park, it continues through developed horse facilities in rural King County and enters left bank Bear Creek just east of the City limits. The Mackey Creek watershed has retained large areas of undisturbed forest. The watershed within the City limits comprises 172 acres and land use is 100 percent parks and undeveloped land, excluding the hobby farm and trail network amenities of the park (Figure 3.20). No stormwater outfalls exist along the creek.

Ecology included Mackey Creek, from Farrel-McWhirter Park down to the confluence with Bear Creek, on the 2008 Section 303(d) as a Category 5 waterbody due to high temperature (Ecology 2008c). It is also listed as a Category 2 waterbody for dissolved oxygen. The B-IBI scores in Farrel-McWhirter Park from sampling that was conducted from 2005 through 2010 indicated good conditions. Bollman (2011) reported that Mackey Creek had the highest average B-IBI scores of any tested stream in the City, exhibiting characteristics of an undisturbed stream such as high overall taxa richness, large numbers of unique taxa, and presence of all expected functional groups (for example gatherers, filterers, scrapers, etc.). The median B-IBI score for Mackey Creek based on data collected by the City as part of the Annual Benthic Monitoring Study (2005 through 2010) is 38, indicating good conditions (PSSB 2011). This is above the B-IBI score threshold typically indicative of supporting self-sustaining salmonid populations.

Dense stands of mature conifers provide good cover for the stream, though there is limited wood present in the stream channel, and there are long riffle reaches with little instream diversity. Large numbers of downed trees span the channel in the lower reaches, though most are not located in the wetted channel. The stream channel is braided through a large reed canarygrass patch in the west portion of Farrel-McWhirter Park.

Washington Trout crews did not survey Mackey Creek; however, coho salmon use of Mackey Creek for spawning has been documented (WDFW 2011). Also, numerous trout were observed during a reconnaissance by the City. Mackey Creek is one of the larger tributaries to Bear Creek within the City limits, and as such has high potential use by salmonids. There is one complete and one partial fish barrier on the right bank tributary at the eastern boundary of Farrel-McWhirter Park (Figure 3.20). Several other barriers exist outside Farrell-McWhirter Park and the Redmond Watershed Preserve Park in King County.

3.5.2.7 Monticello Creek

Monticello Creek is a right bank tributary of Bear Creek. The main stem originates in King County, north of the City boundary, and flows south and east. A right bank tributary joins the main stem from the west within the City, and another right bank tributary enters the stream from the south in King County. The headwaters of Monticello Creek are in King County and are dominated by large lots and pastures. The northernmost reach within the City limits flows through Northeast Redmond Neighborhood Park, a 5-acre wooded parcel. The mouth of the creek is located in the Middle Bear Creek Natural Area. The total stream length is 9,878 linear feet; 6,125 linear feet are within the City, of which 3,170 linear feet are designated as a Class II stream. An average of 3.5 stormwater outfalls can be found per 1,000 feet along the creek.

The Monticello Creek watershed is 345 acres; 264 acres are within the City limits. Land use is predominantly single-family residential, parks and undeveloped land (Figure 3.21). There is a relatively low EIS area within the City portion of the watershed (23 percent). Land cover is mostly landscaping (Figure 3.21).

Ecology included a segment of Monticello Creek on the 2008 Section 303(d) list as a Category 5 waterbody due to high temperature. Monticello Creek also has an Ecology-approved TMDL (now listed as a Category 4A waterbody) due to impairment from fecal coliform bacteria. The listed segment is located in King County from the east boundary of the City near 178th Street downstream to the mouth (Ecology 2008c). The median B-IBI score for Monticello Creek based on data collected by the City as part of the Annual Benthic Monitoring study (2005 through 2010) is 36, indicating fair conditions (PSSB 2011). Next to the scores for Mackey Creek, these are the highest B-IBI scores on any City stream outside the Redmond Watershed Preserve Park, and above the B-IBI score threshold indicative of supporting self-sustaining salmonid populations.

Riparian buffers are relatively dense in the upper stream channel, with a narrow band of trees on both sides of the channel. Riparian buffers on the main stem downstream, along Avondale Road NE, are modest. Riparian buffers on the west tributary lack tree cover in most areas (Washington Trout 2005).

There are five full fish passage barriers on the main stem and west tributary and two other partial barriers (Figure 3.21). In addition, steep gradients and unknown channel conditions between the City limits and Avondale Road NE may create fish passage issues. Fish passage through the culvert under Avondale Road NE is questionable. Significant salmonid use has been documented in the lower 2,400 feet of the main stem (Washington Trout 2005).

3.5.2.8 Perrigo Creek

Perrigo Creek is a right bank tributary that enters Bear Creek immediately east of Avondale Road NE. It originates in Jonathan Hartman Park where a large wetland contributes groundwater and seasonal surface water flow to the stream. The upper reaches were relocated and stabilized by the City in 1999 and 2005. The middle reach is ditched through areas of multifamily development, lined with quarry spalls, and has a very limited vegetated buffer. The lower reach is routed into a pipe and roadside ditch. The entire stream length

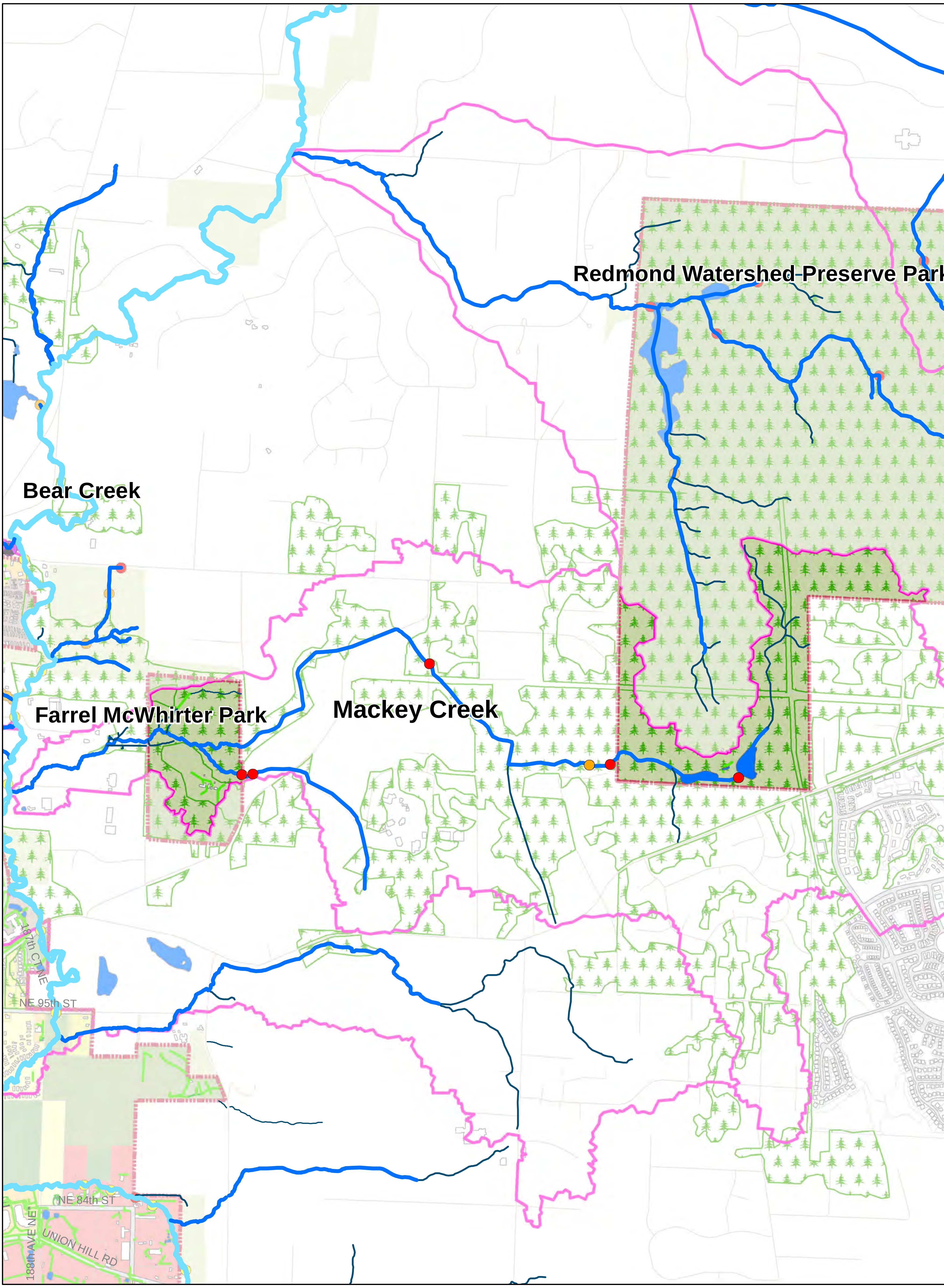

Figure 3.20 - Existing Watershed Conditions For Mackey Creek

City of Redmond, Washington
11/22/2013

0 0.125 0.25 0.5 Miles

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Legend

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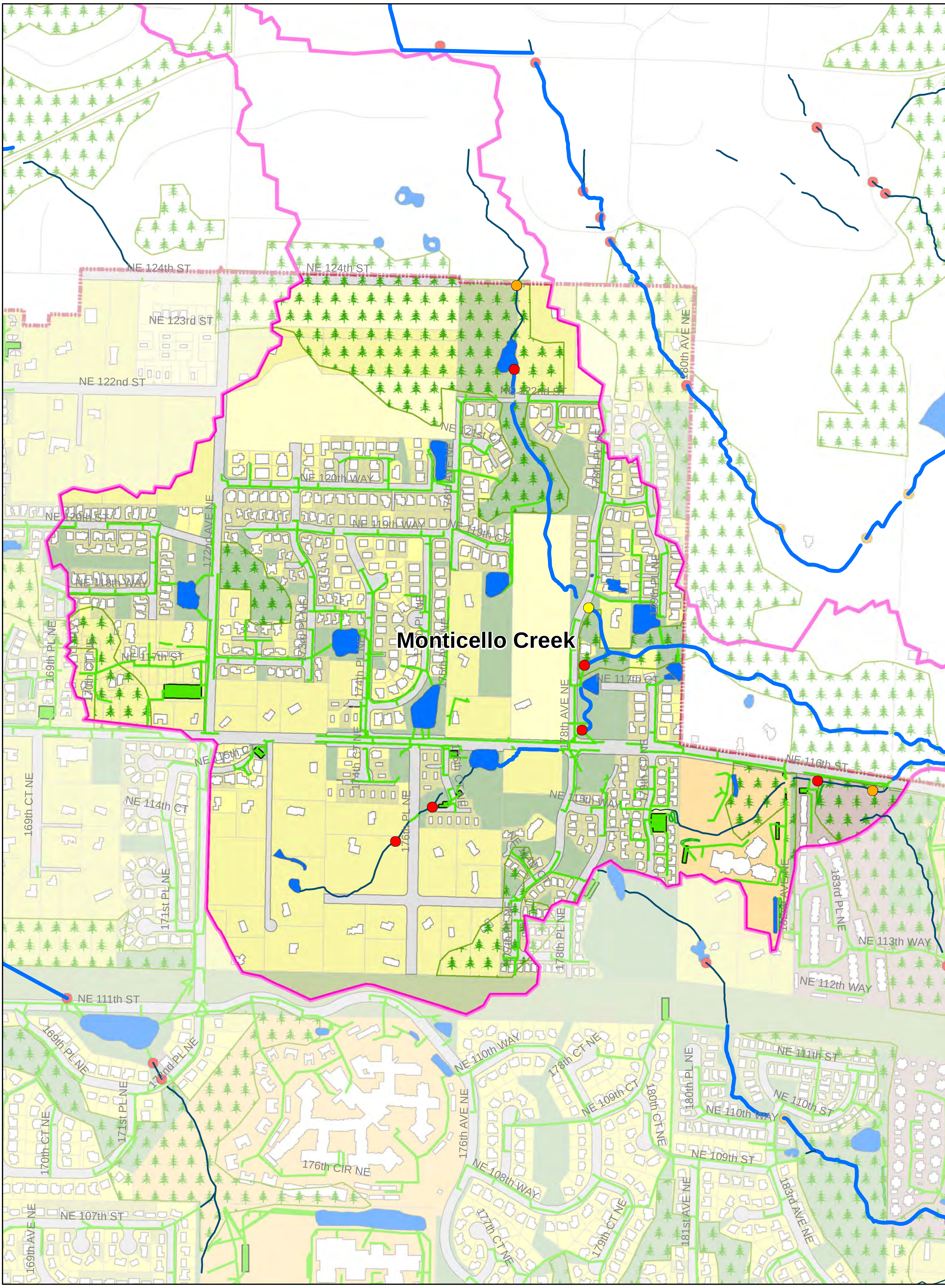

Figure 3.21 - Existing Watershed Conditions For Monticello Creek

City of Redmond, Washington

11/22/2013

0 0.05 0.1 0.2 Miles

N

City of Redmond WASHINGTON

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- Single Family Rural Density

(5,455 linear feet) is located within the City, and 4,280 linear feet is designated as a Class II stream. An average of 3.7 stormwater outfalls can be found per 1,000 feet along the creek.

The Perrigo Creek watershed is 509 acres; the vast majority of this area (503 acres) is within the City limits and has been highly impacted by single-family and multifamily development. Due to Jonathan Hartman Park in the watershed and farmland on the valley floor, a high percentage of the watershed (42 percent) is considered parks and undeveloped land (see Figure 3.22). Land cover in the watershed is approximately evenly divided between forest, pasture, landscaping, and impervious surface. There are large tracts of agricultural land (some of which may not currently drain to the stream) in the valley and dense multifamily residential areas west of Avondale Road NE.

Ecology included the valley reach of Perrigo Creek on the 2008 Section 303(d) list as a Category 5 waterbody for high temperature (Ecology 2008c). The median B-IBI score for Perrigo Creek based on data collected by the City as part of the Annual Benthic Monitoring study (2008, 2009, and 2010) is 32, indicating fair conditions (PSSB 2011). This score may overestimate habitat quality for the creek since the only samples taken were near springs at the headwaters, upstream of degraded valley floor stream reaches that are impacted by development and street drainage.

Riparian buffers are generally narrow and lacking native vegetation, although there is a narrow band of healthy vegetation along the rehabilitated portion of the channel in the upper middle reach. Weedy vegetation is dominant in the buffers downstream of this section. Multifamily housing encroaches on the buffers along both sides of the stream west of Avondale Road NE. In fact, Perrigo Creek has the highest percentage of encroachment in the 30-foot buffer of any of the Class II streams in the City (48 percent).

There are three complete fish passage barriers, three partial barriers, and two potential barriers on Perrigo Creek. The first complete barrier is a 1,000-foot stormwater pipe at Avondale Road NE (Figure 3.22). There was no salmonid use documented in the creek during Washington Trout surveys (Washington Trout 2005).

3.5.2.9 Peters Creek

Peters Creek is located in the west-central portion of the City. It enters the left bank of the Sammamish River north of 90th Street. The “west branch” tributary joins the main stem just upstream of NE 87th Street. The upstream portion of the left bank tributary has its headwaters in Grass Lawn Community Park. The entire stream length (21,325 linear feet) is located within the City, and 12,250 linear feet is designated as a Class II stream. An average of 1.9 stormwater outfalls can be found per 1,000 feet along the creek.

The Peters Creek watershed is 1,045 acres (1,007 acres of which is located in the City).The watershed is highly developed with predominantly single-family dwellings (see Figure 3.23). Land cover is predominantly landscaped yards.

A high-flow bypass structure is located on the main stem of Peters Creek at Old Redmond Road. This drainage structure is designed to bypass flows greater than the 2-year recurrence interval to a separate storm drainage conveyance system that drains directly to the Sammamish River. The intended purpose of this bypass feature is to reduce stream bank erosion caused by high flows in Peters Creek main stem, while maintaining base flows (City of Redmond 2008). This bypass structure generally functions as intended. The City has constructed a variety of other enhancements in the watershed including fish passable weirs at the mouth of Peters Creek, replaced multiple culverts, stabilized channel segments and rehabilitated riparian buffers in several locations. However, there are still many portions of Peters Creek that need rehabilitation.

In general, water quality in Peters Creek is compromised due to the high level of development in the watershed. Ecology included the left bank tributary of Peters Creek from the confluence with the main stem upstream to Redmond Way on the 2008 Section 303(d) list as a Category 5 waterbody due to impairment from low dissolved oxygen concentrations, high temperature, and high fecal coliform bacteria concentrations (Ecology 2008c). The median B-IBI score for Peters Creek based on data collected by the City as part of the Annual Benthic Monitoring study (2002 through 2010) is 20, indicating poor conditions (PSSB 2011).

Riparian habitat on Peters Creek is fair, and is composed of primarily deciduous species and some coniferous species. Riparian habitat is the highest quality in the ravines in the upper portion of the watershed, but is impacted by roads and development in the lower portion of the watershed (Washington Trout 2005). There is a high level of encroachment (19 percent) into the 30-foot riparian buffer.

There are 10 full barriers to fish passage and 6 other partial barriers throughout the watershed (Figure 3.23). However, surveys by Washington Trout indicated significant salmonid use. These surveys indicate there are many more fish using Peters Creek than was previously documented (Washington Trout 2005).

3.5.2.10 Sears Creek

Sears Creek is a tributary of Kelsey Creek; however, although there are areas in Redmond that drain to Sears Creek there is no stream channel or associated buffer within the City limits.

Sears Creek begins west of 148th Avenue NE and discharges to the Kelsey Creek system, which is a Chinook salmon satellite area with moderate Chinook abundance and moderately frequent use (LWCS/WRIA 8 2005). Sockeye salmon, and coho and cutthroat trout are also present in Kelsey Creek. The primary recommendations of the CSCP focus on protection of intact habitat processes and structures by protecting water quality, instream flows, habitat quality, and habitat attributes. Opportunities to implement these recommendations are somewhat limited, nevertheless the City will focus on maintaining and improving water quality in Sears Creek because portions of Kelsey Creek are listed as a Category 4A waterbody on the 2008 Section 303(d) list for high fecal coliform bacteria concentrations, high temperature, and low dissolved oxygen concentrations (Ecology 2008c). To support this effort, the City is developing a conceptual design to provide stormwater flow control for approximately 320 acres that contribute runoff to Sears Creek. This area is designated as a regional urban growth center and is positioned to accommodate urban development.

Within the City’s portion of the watershed (Figure 3.24), land use is primarily commercial (75 percent) with a substantial percent of the drainage (84 percent) comprised of EIS.

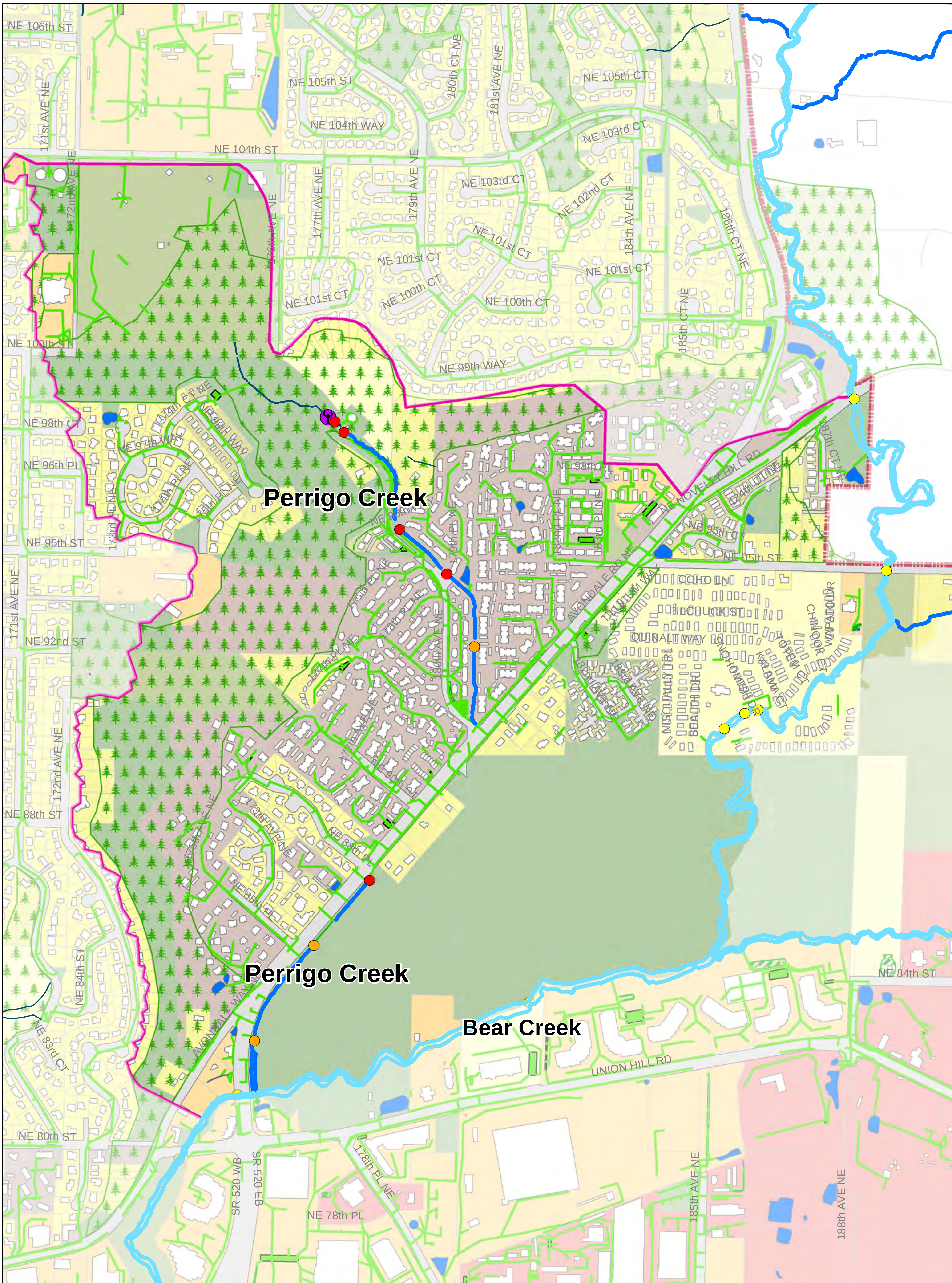

Figure 3.22 - Existing Watershed Conditions For Perrigo Creek

City of Redmond, Washington

11/22/2013

City of Redmond WASHINGTON

0 0.05 0.1 0.2 Miles

N

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Legend

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- Ponds
- Water Quality Monitoring
- Benthic Insect Monitoring
- 0% Passable; Complete Fish Barrier
- 33% Passable; Partial Fish Barrier
- 67% Passable; Partial Fish Barrier
- Forest
- Buildings
- Commercial
- Industrial
- Multifamily
- Park / Undeveloped
- Public ROW
- Single Family HighDensity
- Single Family Low Density
- Single Family Medium Density
- Single Family Rural Density

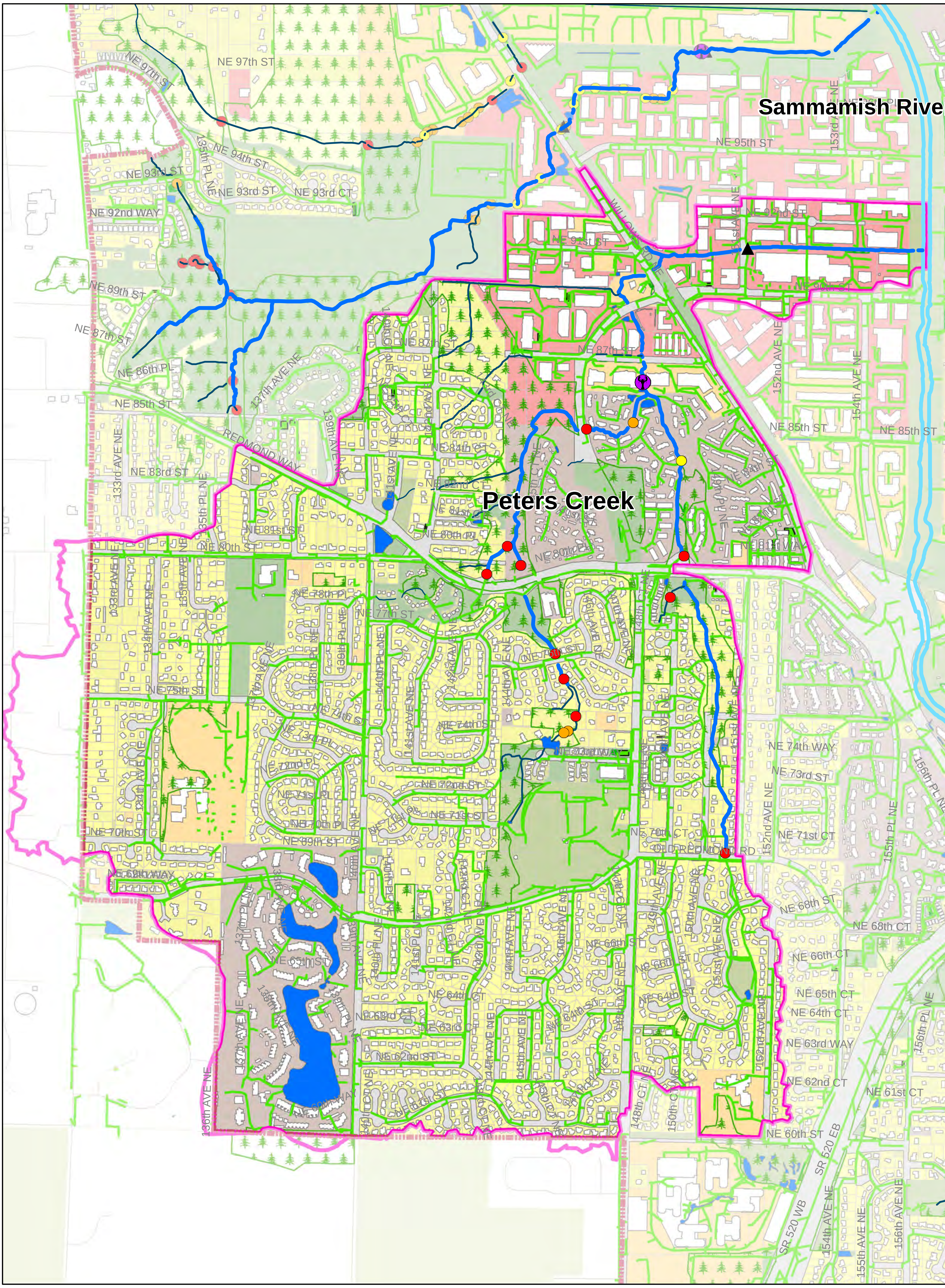

Figure 3.23 - Existing Watershed Conditions For Peters Creek

City of Redmond, Washington

11/22/2013

0 0.1 0.2 0.4 Miles

City of Redmond WASHINGTON

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- Single Family Rural Density

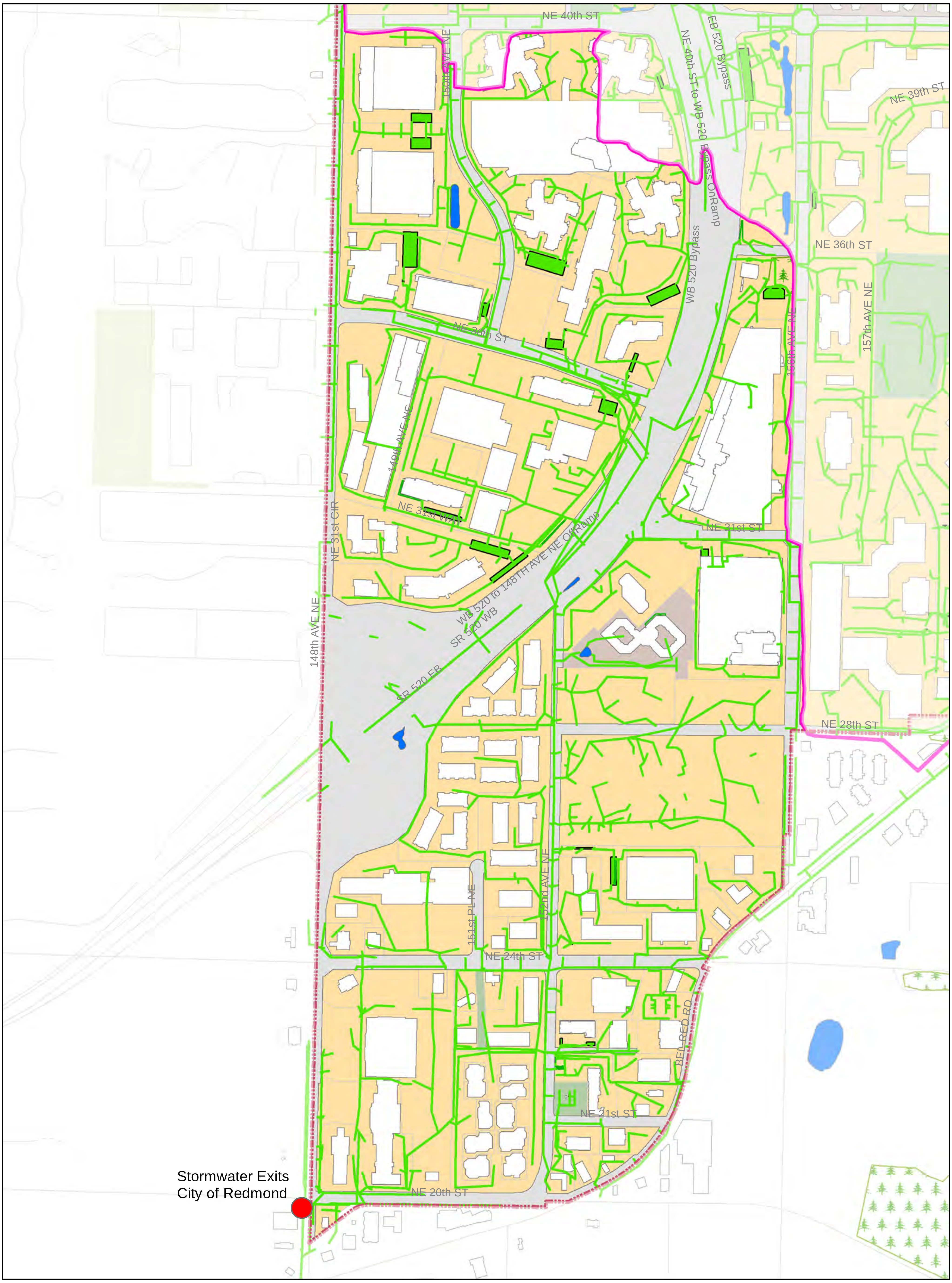

Figure 3.24 - Existing Watershed Conditions For Sears Creek

City of Redmond, Washington

11/22/2013

0 250 500 1,000 Feet

N

City of Redmond WASHINGTON

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3.5.2.11 Seidel Creek

Seidel Creek has its headwaters in the Redmond Watershed Preserve Park (see description under Colin Creek). The East Fork of Seidel Creek joins the main stem within the park. The topography at the headwaters is relatively flat with numerous wetlands, beaver dams, and ponds. The headwaters for Seidel Creek are connected with the same large wetland that is the headwater for Colin Creek. The stream flows through rural King County pasture and wood lots before it enters the left bank of Bear Creek just east of the City limits. The entire stream length is 31,121 linear feet (of which 22,220 linear feet are located within the City and 8,901 linear feet are outside the City). Approximately 13,260 linear feet of Seidel Creek within the City is designated as a Class II stream. There are no stormwater outfalls mapped along the creek.

The Seidel Creek watershed comprises 615 acres and land use is considered 100 percent parks and undeveloped land. Land cover is mostly forest (see Figure 3.25), and the watershed is generally undisturbed. The eastern two thirds of the watershed was logged in the 1930s, and the western third was logged during World War II. The forest has naturally regenerated since then, being protected initially as a municipal water supply, and more recently as a natural park, with a focus on protecting its wide variety of habitats, including ponds and wetlands.

In general, water quality in Seidel Creek is good due to the low level of development. However, Ecology included the lowest 0.1 mile, in unincorporated King County, on the 2008 Section 303(d) list as a Category 5 waterbody due to high temperature (Ecology 2008c). This reach is also listed as Category 2 for dissolved oxygen. B-IBI sampling was not performed by the City on Seidel Creek; however, King County conducted B-IBI sampling in the watershed from 2002 through 2010. Their median B-IBI score for Seidel Creek was 32; indicating fair conditions (PSSB 2011).

All reaches of Seidel Creek are flanked with densely wooded second growth forest. Its headwater is a large wetland complex that feeds both Seidel and Colin Creek. The upper reaches contribute to a manmade water impoundment that is flanked by wetlands and dense forest. Below the dam is also heavily wooded with some prairie within the buffer. The entire portion of Seidel Creek's Watershed within Redmond is within the Redmond Watershed Preserve and is characterized by 83 percent tree cover in the riparian zone.

A low dam backs up water below the confluence with the East Fork of Seidel Creek to create a reservoir. The reservoir was originally used as a municipal water supply but due to water quality issues was abandoned in 1953. However, this dam now represents a complete fish passage barrier. There are two other barriers upstream on the East Fork, and one partial barrier (a concrete flume) upstream on the main stem (Figure 3.25). There are large numbers of resident salmonids that use Seidel Creek, but no anadromous fish due to the fish passage barriers. This issue is being addressed with a fish passage project. No surveys of Seidel Creek were done by Washington Trout.

3.5.2.12 Tosh Creek

Tosh Creek is located in the southwest portion of the City. Tosh Creek enters the left bank of the Sammamish River just upstream of the weir at the boundary of Marymoor Park. The upper reaches flow through residential areas. The majority of the valley reaches are in good condition with wide forested buffers. Numerous seeps and small tributaries help maintain consistent base flows. The channel is straightened and ditched in the reach downstream of WLSP. The total stream length is 10,370 linear feet, of which 7,215 linear feet is designated as a Class II stream. The stormwater influence in the Tosh Creek watershed is not as significant as in some of the adjacent watersheds because some of the developed commercial area in the upper reaches is piped to Villa Marina Creek via a stormwater trunk line. An average of 0.8 stormwater outfalls can be found per 1,000 feet along the creek.

The Tosh Creek watershed within the City is 276 acres; the entire watershed is 299 acres. The remainder of the watershed is in King County ownership. The Tosh Creek watershed is highly developed with predominantly single-family dwellings (see Figure 3.26). Within the watershed, approximately 39 percent of the area can be considered EIS. Land cover is divided evenly between landscaped yards and impervious surface (39 percent each), with minor amounts of forest and pasture.

Ecology included a segment of Tosh Creek upstream of WLSP on the 2008 Section 303(d) list as a Category 5 waterbody due to impairment from fecal coliform bacteria (Ecology 2008c). The median B-IBI score for Tosh Creek based on data collected by the City as part of the Annual Benthic Monitoring study (2008, 2009, and 2010) is 19, indicating poor conditions (PSSB 2011). This rating may be misleading because the samplers inadvertently chose locations with some of the poorest water quality on the stream (R. Dane, personal communication, December 5, 2011). The City expects higher B-IBI scores for Tosh Creek in future sampling efforts as a number of other indicators suggest this stream is relatively healthy.

Riparian buffers are generally broad and mostly in good condition with abundant trees in the valley wall reaches. In the upper reaches through residential areas, the riparian buffers are narrower and mature trees are less abundant. However, the steep valley slopes in the upper reaches provide a natural buffer against further development and there are sufficient deciduous trees to provide shade (Washington Trout 2005). There is a minor amount of development (four percent) within the 30-foot stream buffer.

There are three fish passage barriers on Tosh Creek, and one former barrier that has been removed for fish passage. One of the barriers on a left bank tributary near WLSP is a complete barrier. The other two are partial barriers on the main stem at WLSP (Figure 3.26). Significant salmonid use has been documented in Tosh Creek as far upstream as the south fork at the headwaters. Abundant gravel in the lower reach makes this stream a potentially important coho spawning stream (Washington Trout 2005).

3.5.2.13 Tyler's Creek

Tyler's Creek is a right bank tributary of Bear Creek. It originates west of Avondale Road NE in the northeast portion of the City and flows south and east, joining Bear Creek just east of the City limits. Sediment loads from the steep channel on the hillside and thick vegetation combine to create a braided channel through the wetland at the base of the valley wall. The total stream length is 3,417 linear feet; 2,990 linear feet are within the City, of which 2,020 linear feet are designated as a Class II stream. An average of three stormwater outfalls can be found per 1,000 feet along the creek.

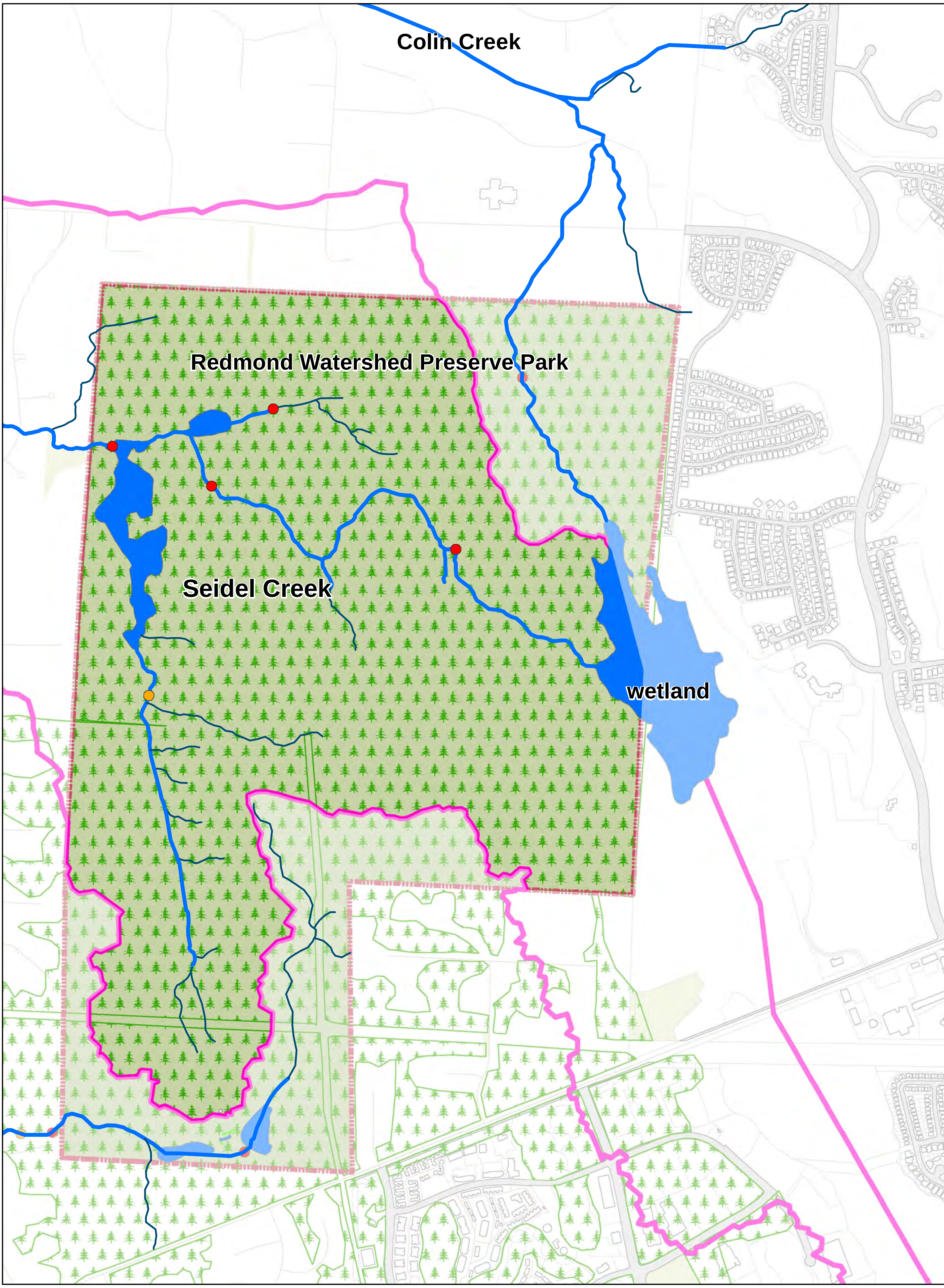

Figure 3.25 - Existing Watershed Conditions For Seidel Creek

City of Redmond, Washington
11/22/2013

0 0.1 0.2 0.4 Miles

City of Redmond WASHINGTON

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- Single Family Rural Density

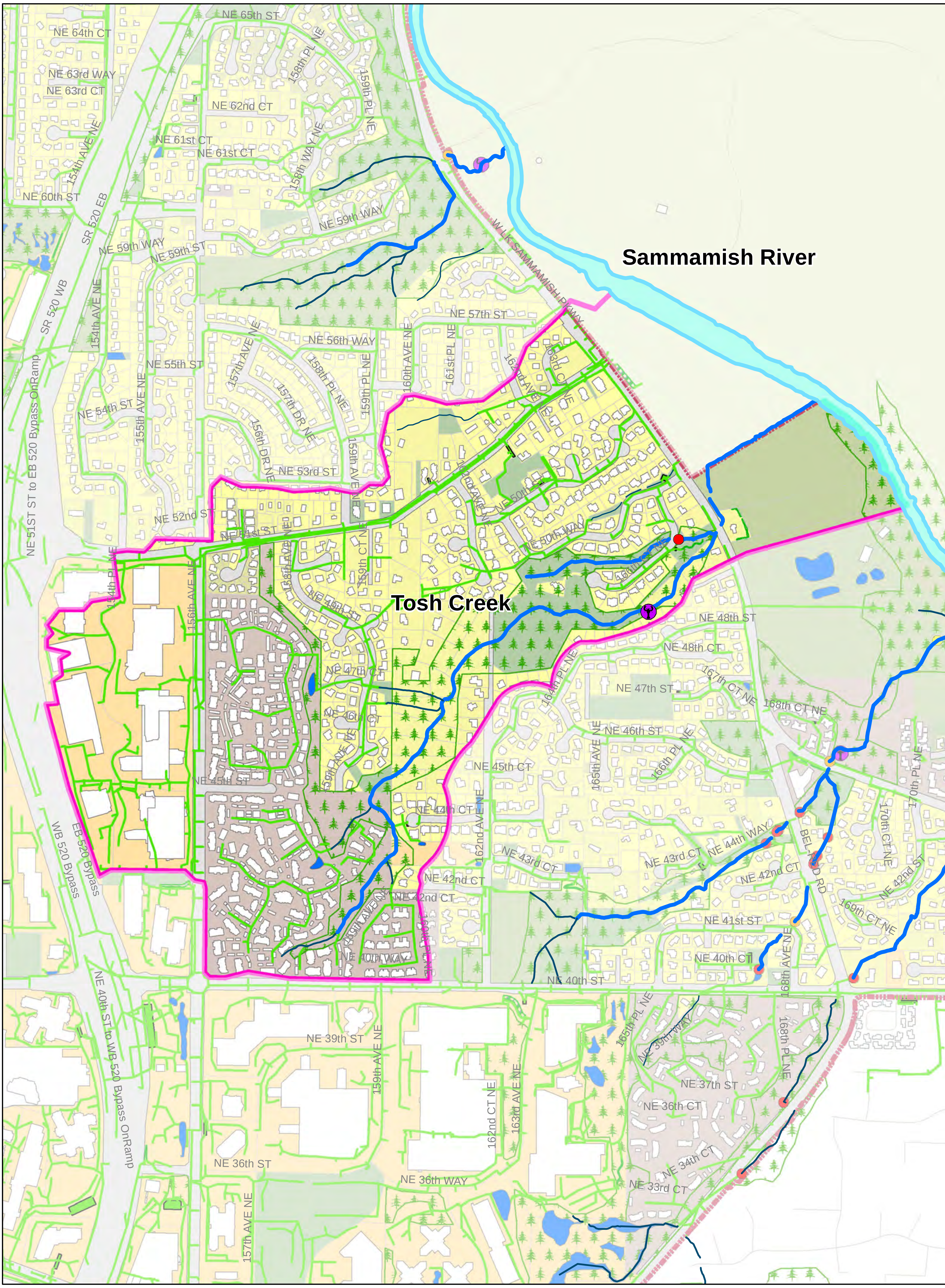

Figure 3.26 - Existing Watershed Conditions For Tosh Creek

City of Redmond, Washington

11/22/2013

0 0.05 0.1 0.2 Miles

N

City of Redmond WASHINGTON

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- Single Family Rural Density

The Tyler's Creek watershed is 168 acres, and 167 acres are located in the City. Land use is predominantly single-family residential. There are large tracts of undeveloped land in the headwaters (see Figure 3.27). Land cover is primarily landscaping (43 percent) and impervious surface (35 percent). There are a relatively high number of stormwater outfalls along Tyler's Creek (three outfalls per 1,000 linear feet).

Ecology included all of Tyler's Creek on the 2008 Section 303(d) list as a Category 5 waterbody due to high temperature (Ecology 2008c). The median B-IBI score for Tyler's Creek based on data collected by the City as part of the Annual Benthic Monitoring study (2005, 2006, and 2007) is 20, indicating poor conditions (PSSB 2011). These samples were collected from two sites west of Avondale Road NE (PSSB 2011).

Riparian buffers are in fair condition, with only 10 percent encroachment within 30 feet of the stream and well-established riparian plantings. Most of the buffers are protected within Native Growth Protection Easements (NGPEs) or tracts within the City limits. However, the protected easements are much narrower than present standards. Some upper reaches of the stream channel were rehabilitated and several fish barriers corrected, but the habitat is poor quality having uniformly sized rock, plastic fabric, and large riprap weirs.

There are two partial fish passage barriers on Tyler's Creek: a baffled culvert under Avondale Road NE and a second barrier upstream. There are two other potential barriers, one at the mouth and one near the headwaters (Figure 3.27). No significant salmonid use has been documented in Tyler's Creek, although Washington Trout crews did document salmonids upstream of Avondale Road NE (Washington Trout 2005).

3.5.2.14 Valley Estates Creek

Valley Estates Creek is located in the northern portion of the City and is entirely within the City limits. It is a right bank tributary of the Sammamish River. The total stream length is 3,135 linear feet, of which 2,010 linear feet is designated as a Class II stream. Most of the stream is piped above the valley walls, and there are almost no stormwater detention or runoff treatment facilities, though a high-flow bypass was installed in 2011 that diverts storm flows around the stream directly to the river. An average of three stormwater outfalls can be found per 1,000 feet of stream.

The Valley Estates Creek watershed is 172 acres. It is highly developed with predominantly single-family dwellings (see Figure 3.28). Land cover is predominantly landscaped yards and 35 percent of the watershed is EIS.

Ecology included Valley Estates Creek (from the mouth upstream to Redmond Woodinville Road) on the 2008 Section 303(d) list as a Category 5 waterbody due to impairment from fecal coliform bacteria (Ecology 2008c). The median B-IBI score for Valley Estates Creek based on data collected by the City as part of the Annual Benthic Monitoring study (2008 and 2009) is 18, indicating the low end of poor conditions (PSSB 2011).

The valley floor reach is relatively straight and appears to have been ditched in the past. The narrow buffers have been revegetated with rapidly maturing native plants. A steep wooded ravine is located upstream, which provides a relatively wide buffer of deciduous forest.

Three fish passage barriers near the confluence with the Sammamish River were removed in 2011, and the lower channel of Valley Estates Creek was rebuilt. A perched culvert at Redmond Woodinville Road creates another complete barrier however, there is no Class II water upstream (Washington Trout 2005) (Figure 3.28). No significant salmonid use has been observed in Valley Estates Creek, although Washington Trout crews did observe salmonids in the Sammamish River near the mouth (Washington Trout 2005).

3.5.2.15 Villa Marina Creek

Villa Marina Creek flows roughly northeastward, paralleling Bellevue Redmond Road (Bel Red Road). Villa Marina Creek turns due east in a ditch section between multifamily housing complexes as it passes beneath WLSP and then discharges into Lake Sammamish near the lake outlet. The total stream length within Villa Marina Creek watershed is 5,257 linear feet, 3,920 linear feet of which is located within the City limits. The entire stream length that is designated as a Class II stream (2,470 linear feet) is located within the City limits. An average of 1.6 stormwater outfalls can be found per 1,000 feet along the creek.

The total area of the Villa Marina Creek watershed within the City limits is 365 acres. The entire watershed is 589 acres. A portion of the watershed is located within the City of Bellevue. The watershed within the City is highly impacted by commercial development (see Figure 3.29), and includes a large stormwater trunk line from upstream commercial areas that discharges into the channel near WLSP. Impervious surface is the dominant land cover, comprising 64 percent of the watershed within the City. The northwest portion of the watershed's drainage flows towards NE 40th Street. These flows are collected in the NE 40th Street trunkline (bypass). The bypass carries the storm flows due east and discharges to Villa Marina Creek through an energy dissipation structure near WLSP.

In general, water quality in Villa Marina Creek is compromised due to the high level of development. Ecology included the main stem of Villa Marina Creek on the 2008 Section 303(d) list as a Category 5 waterbody for low dissolved oxygen, high temperature, and high fecal coliform bacteria (Ecology 2008c). The median B-IBI score for Villa Marina Creek based on data collected by the City as part of the Annual Benthic Monitoring study (2008 and 2009) is 19, indicating poor conditions (PSSB 2011).

Instream habitat east of WLSP is limited by very narrow buffers, little instream structure, and channelization with some areas armored with concrete. There is an area of high quality lakeshore willow habitat located at the downstream end of the stream channel. Riparian buffer habitat is rated very poor with a high level of buffer encroachment and poor instream habitat rating (R. Dane, personal communication, December 5, 2011). West of WLSP, woody debris is sparse, but there is adequate spawning gravel and rearing habitat in small pools (Washington Trout 2005).

There are one partial and two complete fish passage barriers at WLSP, and three other barriers further upstream, including two culverts at Bel Red Road (Washington Trout 2005) (Figure 3.29). No fish were observed west of WLSP during Washington Trout surveys and there is low likelihood of significant salmonid use.

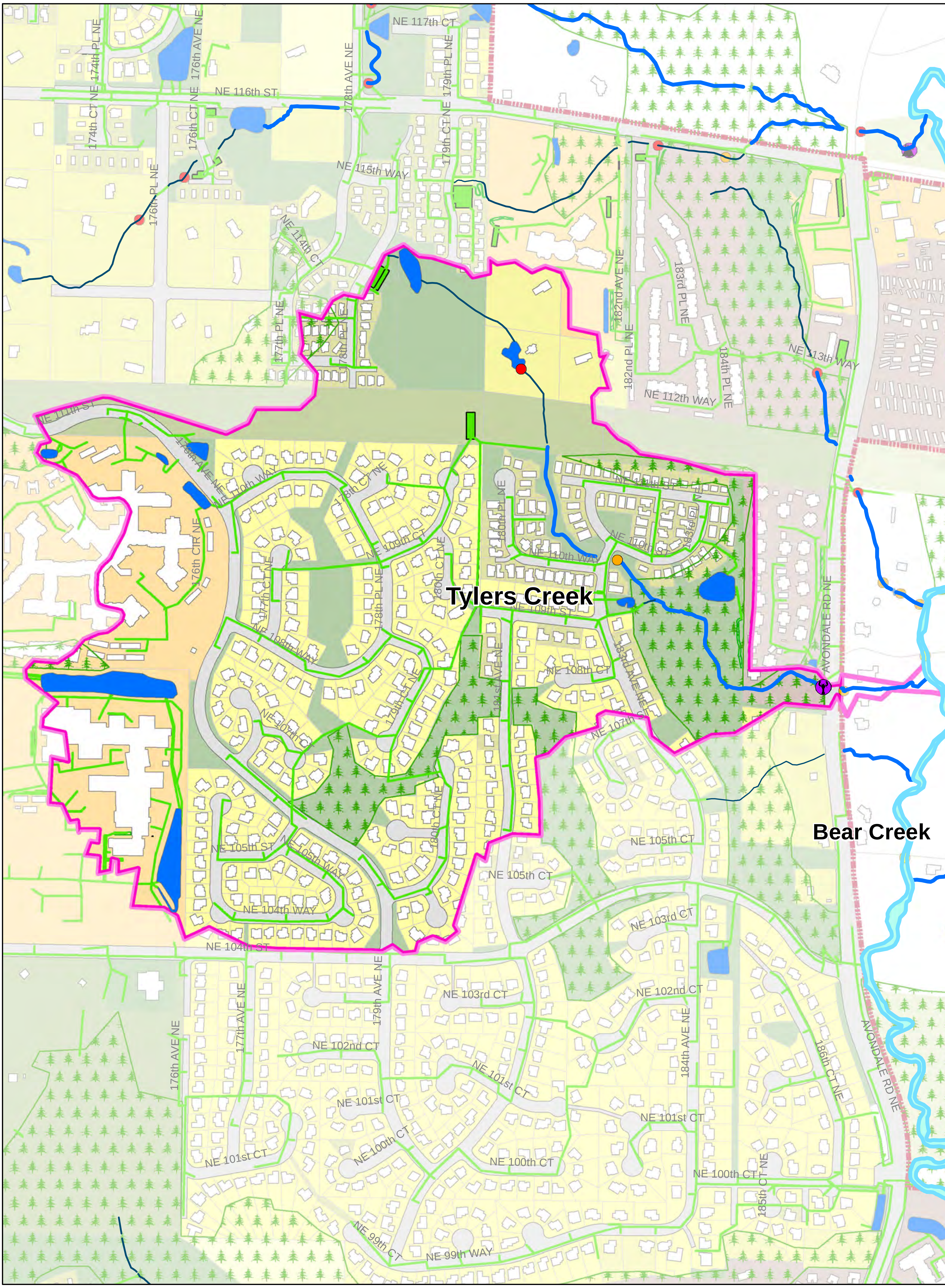

Figure 3.27 - Existing Watershed Conditions For Tylers Creek

City of Redmond, Washington

11/22/2013

N

0 0.05 0.1 0.2 Miles

City of Redmond WASHINGTON

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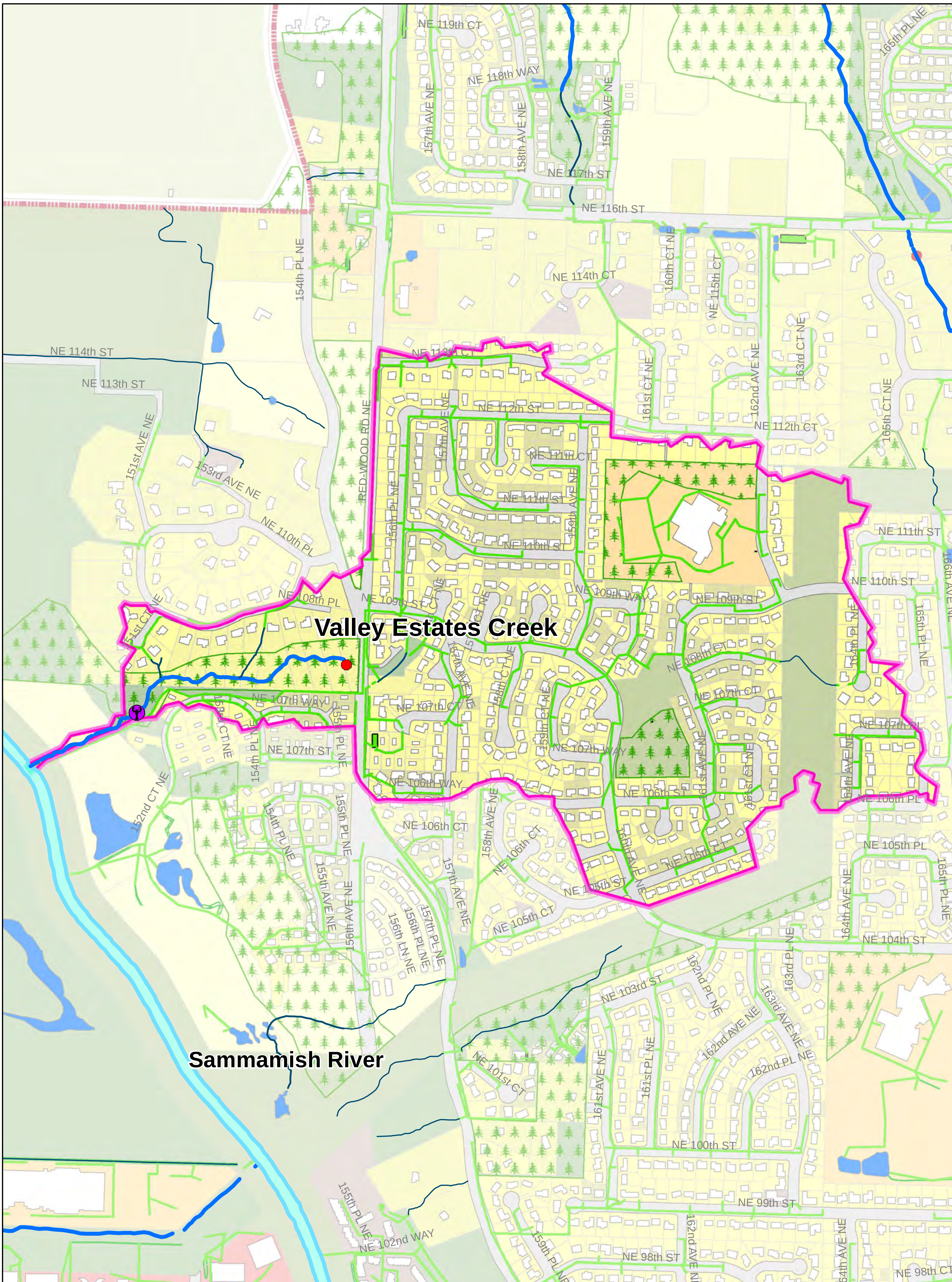

Figure 3.28 - Existing Watershed Conditions For Valley Estates Creek

City of Redmond, Washington

11/22/2013

N

0 0.05 0.1 0.2 Miles

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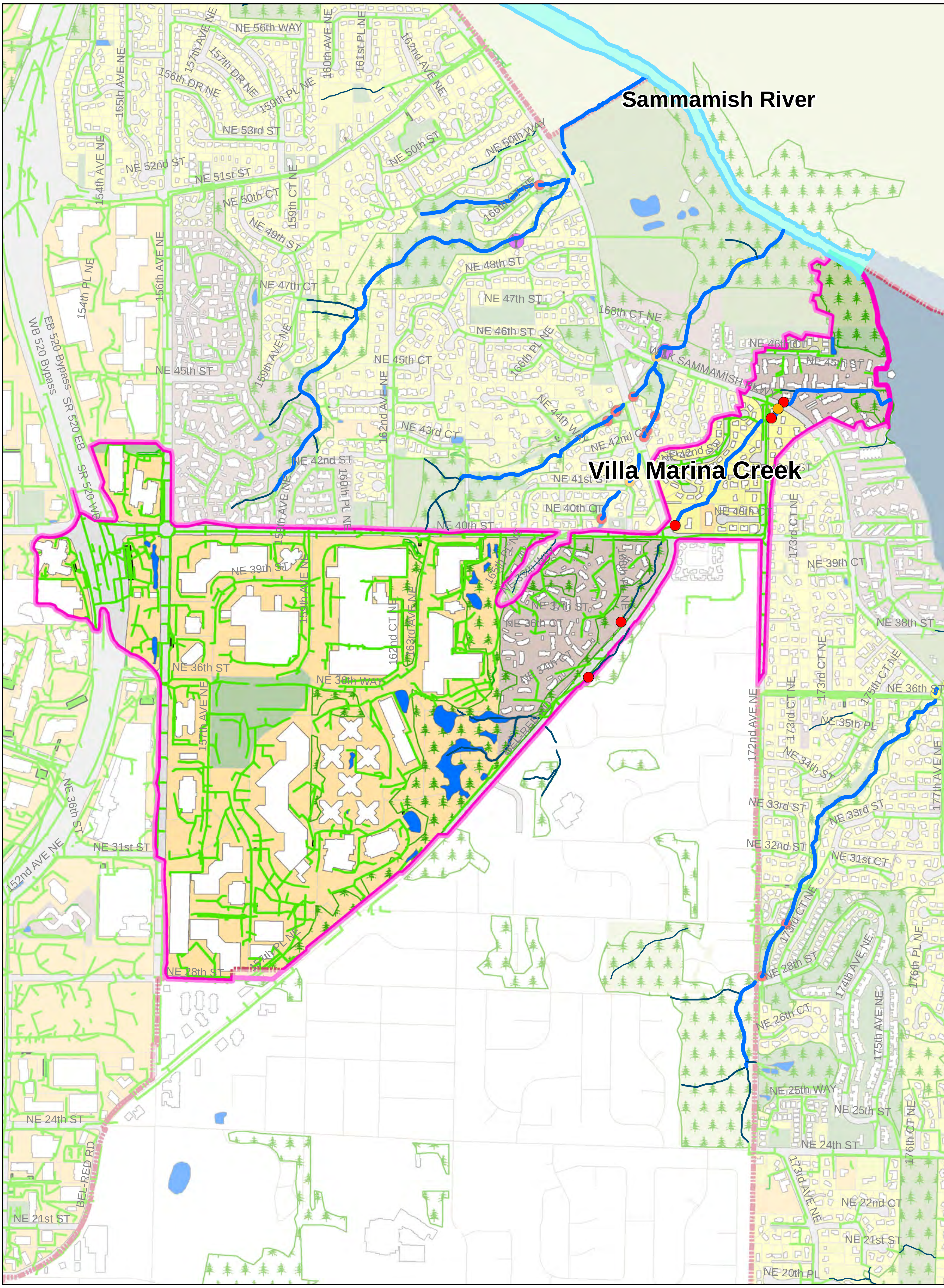

Figure 3.29 - Existing Watershed Conditions For Villa Marina Creek

City of Redmond, Washington

11/22/2013

N

0 0.1 0.2 0.4 Miles

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3.5.2.16 Willows Creek

Willows Creek is located in the west-central portion of the City, entering the left bank of the Sammamish River north of 95th Street. Willows Creek runs west to east with about a third of its watershed represented by three headwater tributaries that combine at the upper end of a large central wetland. Steep slopes occur along the edge of the plateau at the upper end of the undeveloped central portion of the watershed. Nearly all of the system is piped above the valley walls. It appears that in the past a major tributary joined the main stem of the creek on the left bank near Willows Road. This tributary is currently isolated from the rest of the system, but it may be possible to realign the channel to combine the flows in the future. While the tributary is highly degraded in its lowest reaches, the valley wall reaches generally have broad forested buffers, and fair quality instream habitat. The total stream length is 13,040 linear feet, all of which is located within the City limits and 9,835 linear feet of which is designated as a Class II stream. An average of 1.1 stormwater outfalls can be found per 1,000 feet along the creek.

In the 463-acre watershed for Willows Creek, the dominant land uses are single-family residential and parks and undeveloped land (see Figure 3.30). The watershed includes a Puget Sound Energy power line right-of-way, a generally grassy corridor that also includes the Puget Powerline Trail. Several of the headwater tributaries are located in large protected open space areas upstream of Willows Creek Business Park. Land cover in the watershed is dominated by forest and landscaped areas (see Figure 3.30).

A left bank tributary of Willows Creek is listed on the 2008 Section 303(d) list as a Category 5 waterbody for low dissolved oxygen and high fecal coliform bacteria (Ecology 2008c). Willows Creek is also listed as Category 2 waterbody for temperature. However, the mapping for this tributary is inaccurate; the tributary, known as Gun Club tributary, does not connect with Willows Creek. The Gun Club tributary is a Class III stream with wooded buffers. All indicators show that the hydrology supporting the Gun Club tributary is relatively stable. The median B-IBI score for Willows Creek based on data collected by the City as part of the Annual Benthic Monitoring study (2002 through 2010) is 22, indicating poor conditions (PSSB 2011).

Riparian conditions are generally poor in the lower reach, with inadequate tree and shrub cover due to Puget Sound Energy's policy of preventing tree establishment under their power lines. A relatively high level (17 percent) of development is encroaching into the 30-foot stream buffer. In the upper reach, most of the riparian zone is protected in large NGPEs, large tracts, or utility corridor open space.

There are 14 partial fish passage barriers on the middle reach, and one complete barrier at the power line culvert near the headwaters, approximately 5,500 feet upstream of the mouth (Washington Trout 2005) (Figure 3.30). Significant salmonid use has been observed on the main stem (Washington Trout 2005). A few pairs of coho salmon have been regularly observed spawning in Willows Creek.

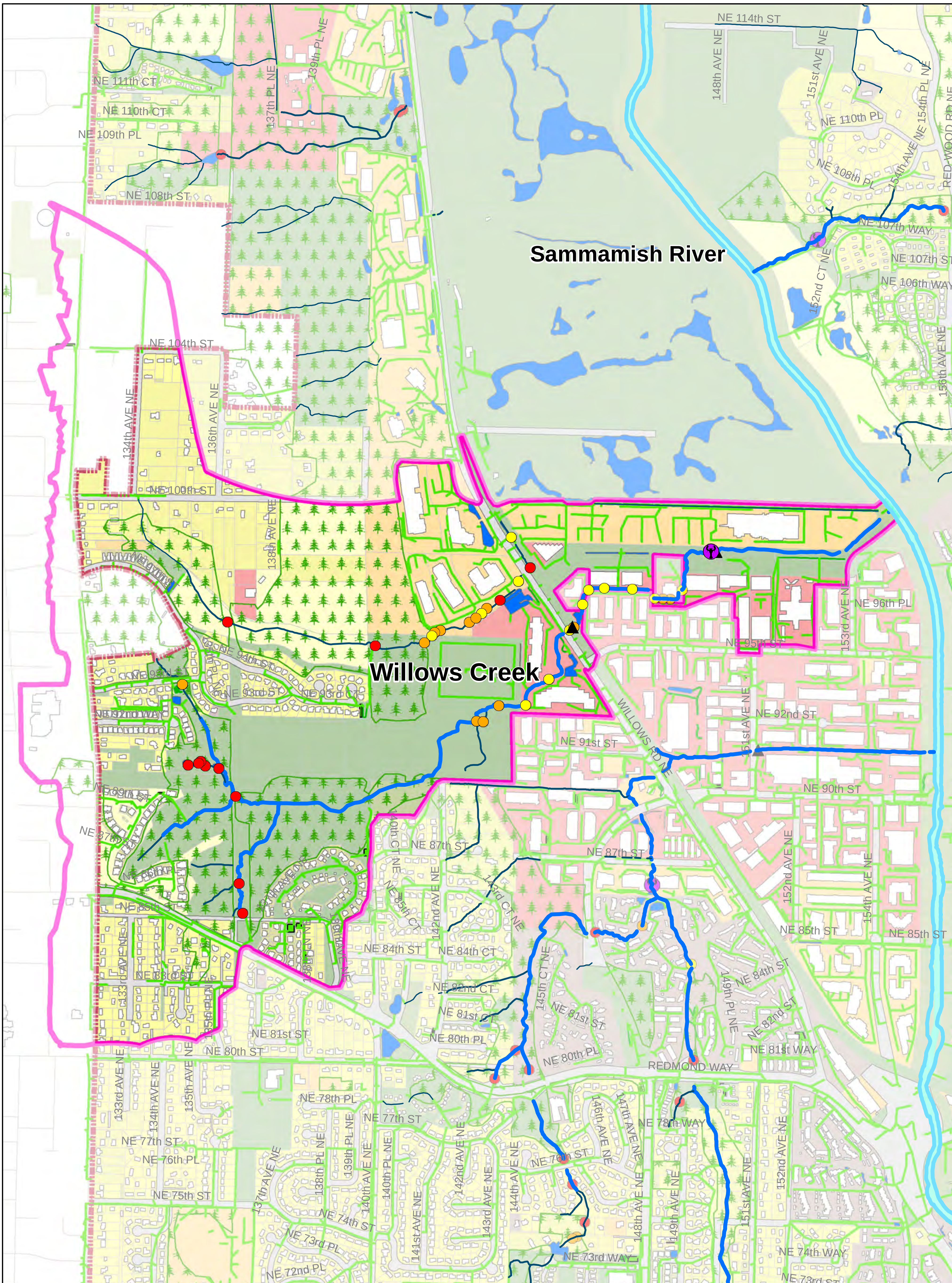

Figure 3.30 - Existing Watershed Conditions For Willows Creek

City of Redmond, Washington

11/22/2013

0 0.1 0.2 0.4 Miles

N

Legend

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City of Redmond WASHINGTON

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Chapter 4 WATERSHED PLANNING APPROACH

- **The most effective approach to restoring water resources and effecting positive change is through a planning structure that capitalizes on environmental opportunities within each unique watershed while working within regulatory requirements.**
- **We will achieve more immediate and measurable positive results by implementing a watershed-based approach to stormwater management than would be obtained from only regulating individual projects.**
- **The WMP allows for efficient use of rehabilitation dollars through targeted projects tailored to specific watershed needs.**
- **This holistic approach will prevent further degradation in all watersheds.**
- **Guiding principles are applied to identify watersheds where immediate benefits will be realized through rehabilitation.**

Stormwater management and watershed rehabilitation are complex endeavors. The wide range of multifaceted regulatory drivers that must be met combined with diverse environmental conditions, present significant obstacles to holistic watershed management. Nonetheless, the City believes that in the long term, the most efficient and effective approach to restoring water resources and effecting positive change is through a planning structure that capitalizes on environmental opportunities within each unique watershed while working within regulatory requirements. By implementing a watershed-based approach to stormwater management, the City expects to achieve more immediate and measurable positive results in water resource conditions than would be obtained from only regulating individual projects.

As outlined in *Chapter 2: Regulatory Drivers*, there are many regulations that dictate the obligations of the City, developers, landowners, and others with respect to water resource management. While each of the regulations are designed to accomplish specific water resource goals, and generally are effective at meeting their independent goals, the regulations are based on state and federal policies and guidelines, and are not always tailored to specific conditions in the City and its watersheds. Moreover, the regulations are not all encompassing or seamlessly integrated, resulting in gaps and inconsistencies with respect to directing holistic watershed improvements.

As a result, the default approach by many jurisdictions is to meet the requirements of each regulation independently, without tailoring those requirements to specific watershed needs. In addition, many of the applicable regulations are reactive, triggering environmental requirements based on land use actions, development, or discrete observed watershed conditions. The result is a shotgun approach to watershed management that directs improvements and protections based on independent, generally non-coordinated actions (e.g., when development occurs, where significant environmental degradation has been documented, or as part of broader land use planning efforts), rather than focusing efforts where they will provide the greatest environmental benefit.

The City's proposed watershed approach looks at existing conditions within each watershed; identifies the associated needs, requirements, opportunities, and constraints; and then focuses rehabilitation efforts on priority areas and issues that have the greatest potential to protect or improve beneficial uses in City watersheds. The benefits of this approach include:

- Prioritization of water resource projects where they will provide the most benefit
- Integration of interrelated regulatory requirements into a common strategy
- Realization of greater environmental improvement in a shorter period of time compared to spot improvements tied to individual development projects
- More efficient use of rehabilitation dollars through targeted projects tailored to specific watershed needs (essentially projects designed and located where the benefits can be most significant)

The details of this approach (relative to each regulatory driver) are outlined in the subsequent sections, and the overall implementation strategy is discussed in *Chapter 5: Implementation Strategy*.

4.1 Watershed Management Strategy Prioritization

The specific goal of the watershed approach identified in this WMP is to direct certain rehabilitation efforts to watersheds where they will provide the most immediate environmental benefit. At the same time, the WMP approach will prevent (at a minimum) further degradation in all watersheds. As individual priority watersheds are rehabilitated under this WMP, remaining watersheds will be prioritized for improvement through updates to this WMP until all the City's watersheds have been rehabilitated to target levels.

To identify broad management strategies for the City's watersheds, a course level screening was performed using the Puget Sound Characterization tool (Stanley et al. 2011). The Puget Sound Characterization is a regional-scale tool that highlights the most important areas to protect, and restore, and those most suitable for development. Following this course level screening, more detailed information presented in *Chapter 3: Watershed Conditions* was used to identify specific management strategies for each of the City's 20 watersheds. The results from these separate evaluations are summarized in the following subsections.

4.1.1 Prioritization Based on Puget Sound Characterization

The Puget Sound Watershed Characterization is a set of spatially explicit water and habitat assessments that compare areas within a watershed in terms of their relative suitability and value for restoration and protection (Stanley et al. 2011). The assessments cover water resources (both water flow and water quality) and fish and wildlife habitats in terrestrial, freshwater and marine nearshore areas over the entire drainage area of Puget Sound. Results from the assessments of water flow were used to screen watersheds within the City to identify candidate watersheds for intensive, near-term rehabilitation efforts under this WMP.

The assessment for water flow combines results from different models that evaluate the “importance” and “degradation” of small watersheds, referred to as Assessment Units (AUs), with respect to the following water-flow processes:

- **Delivery** – The Delivery model assesses those physical features that control how precipitation is delivered to the landscape. This includes the quantity of precipitation, area of forest cover, and rain on snow zones.
- **Surface Storage** - The Surface Storage model assesses those features that control the movement of water at the surface, including depressional wetlands and floodplains.
- **Recharge** - The Recharge model assesses areas that control the infiltration and percolation of precipitation into groundwater.
- **Discharge** - The Discharge model assesses areas that control the movement of groundwater back to the surface, including the area of slope wetlands and floodplains with permeable deposits.

The importance and degradation rankings from these models can be integrated into a matrix that defines broad management strategy recommendations for any given AU (Figure 4-1). The greatest level of management action (broadly denoted “Restoration”) applies to the most important AUs with the greatest existing degradation. Conversely, areas of lower importance due to less degradation likely require a much lower level of management attention (here termed “Conservation”). Those with high importance and low existing degradation may need little or no active management but warrant a high level of protection to maintain high functional conditions; and those with low importance and significant human impact would be lowest in priority ranking for active management. These are thus tagged “Development,” indicating that additional development in this AU will have the lowest overall impact relative to other AUs with respect to water-flow processes.

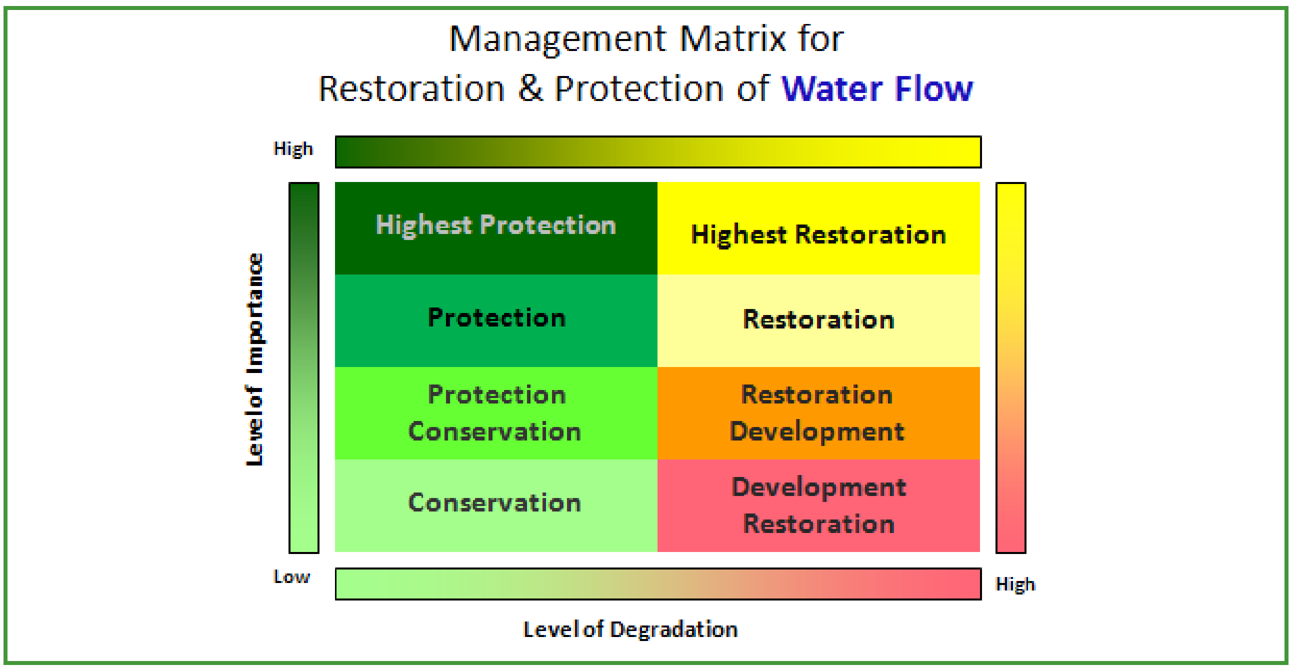

Figure 4.1. Puget Sound Watershed Characterization Management Strategy Matrix.

Results from the water flow assessment can be used to compare AUs across the entire Puget Sound watershed, within a single WRIA, or a single subwatershed within a WRIA. For this evaluation, water flow assessment results were generated to compare recommended management strategies for 22 AUs that encompass most of the City's watersheds. Figure 4-2 shows the locations of these AUs and their corresponding management strategy recommendations. These results identify the following broad patterns for prioritizing rehabilitation efforts in the City's watersheds:

- Clise Creek received a "highest protection" recommendation while reaches of Mackey Creek and Evans Creek within the City received a "protection" recommendation. In general, these areas show low degradation and high importance rankings for all of the water-flow processes (delivery, surface storage, recharge, and discharge).
- Reaches of Bear Creek, Perrigo Creek, and Valley Estates Creek within the City received a "highest restoration" recommendation. Reaches of County Creek, Tylers Creek, Villa Marina Creek, and the Sammamish River within the City also received a "restoration" recommendation. These areas show high importance rankings for surface storage while also showing high degradation rankings for the same water-flow process.
- Reaches of High School Creek and Tosh Creek within the City received a "protection/ conservation" recommendation. Reaches of Monticello Creek and Seidel Creek within the City also received a "conservation" recommendation. These areas show low importance rankings and moderate degradation rankings for a majority of the water flow processes.
- Peters Creek and Willos Creek received a "restoration development" recommendation while Idywood Creek, Sears Creek, and Lake Sammamish received a "development restoration" recommendation. These areas show low importance rankings for surface storage and discharge while also showing high degradation rankings for recharge and delivery.

4.1.2 Refined Prioritization by the City of Redmond

The results presented in the previous subsection from the Puget Sound Characterization provide coarse scale information to help inform watershed management decisions. However, the developers of the Puget Sound Characterization anticipated more detailed, finer scale information would be used to identify management strategies for implementation at the watershed or reach scale (Stanley et al. 2011). To that end, the City used the information presented in *Chapter 3: Watershed Conditions* to identify specific management strategies for each of the City's 20 watersheds. In this evaluation, the City considered a broad range of information including existing hydrology, water and habitat quality, and the presence of sensitive species. When developing these strategies, the City also simplified the management strategy recommendations matrix from the Puget Sound Characterization (see Figure 4-1) to utilize only the following broad categories: Protection, Highest Restoration, Restoration, and Restoration Development. When assigning the specific watersheds to these categories, the City considered both the results from the Puget Sound Characterization summarized in the proceeding subsection and the following guiding principles:

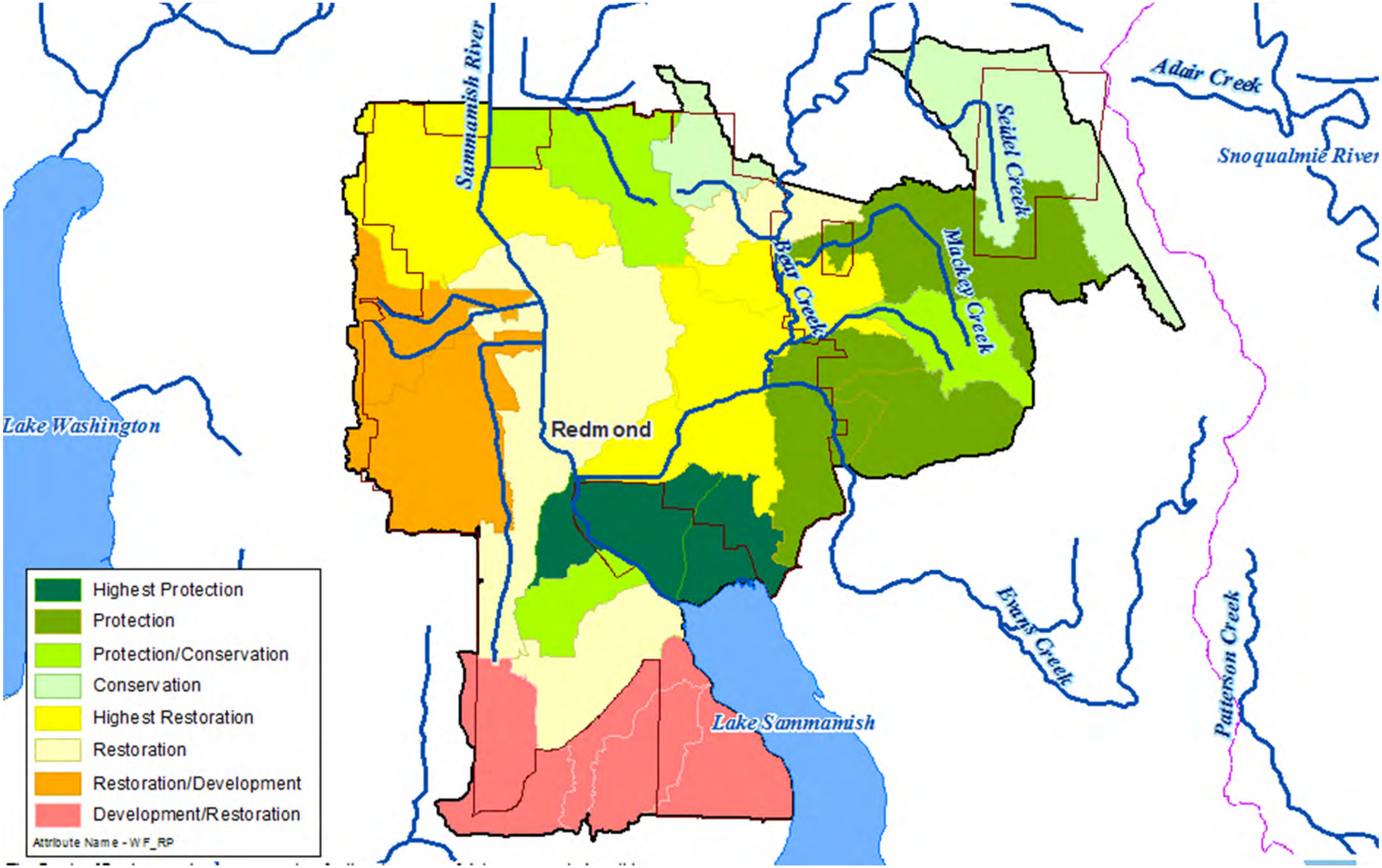

Figure 4.2. Puget Sound Watershed Characterization Water Flow Assessment Results for the City of Redmond.

- **Prioritize watersheds with moderate levels of impairment**. Watersheds with moderate levels of impairment are expected to respond most quickly to rehabilitation efforts and thus provide immediate benefit. This focus will allow a relatively large number of watersheds to be rehabilitated in a shorter amount of time (compared to the default single site regulatory approach). In general, this is consistent with the approach taken in broader rehabilitation efforts for surface water resources within the Puget Sound region. For example, one of the PSP's ecosystem recovery targets for Puget Sound is to improve mean B-IBI scores for 30 wadeable streams in the Puget Sound watershed from fair (26 to 37) to good (38 to 45) (PSP 2011a) by 2020. This approach is also consistent with guidance from academic research on watershed conditions (Beechie et al. 2008; Palmer et al. 2005; Roni et al. 2002) that recommend resource managers place a high priority on preservation of remaining high quality stream riparian ecosystems, and focus stream and watershed rehabilitation efforts on streams that are degraded but likely to respond to improvements. Under an alternate approach that targets only severely impaired watersheds for rehabilitation efforts, it might take decades to see even one watershed significantly rehabilitated.
- **Prioritize watersheds where the City can affect the most influence**. As described in *Chapter 3: Watershed Conditions*, a number of watersheds in the City are part of much larger watersheds located beyond the City's jurisdictional boundaries. As such, the City often has little control over activities that are contributing to overall water resource impairment in these watersheds – despite the fact that some of the impaired stream reaches are within the City. To further focus the City's resources on watersheds where the greatest immediate benefit can be achieved, this WMP assigns a higher priority to watersheds that have most of their associated drainage area within the City.
- **Prioritize watersheds where regional rehabilitation efforts are also focused.** As described in *Chapter 3 Existing Watershed Condition*s, the City's Class I streams have been prioritized for either protection and conservation (core and migratory reaches) or rehabilitation (satellite reaches) pursuant to the CSCP (LWCS/WRIA 8 2005). While these Class I streams receive runoff from large areas that are outside the City's jurisdictional boundaries and control, there are several Class II streams within the City that are tributaries to these regionally significant Class I streams. It follows that rehabilitation efforts on these Class Il streams will also benefit the Class I streams. Therefore, this WMP prioritizes the City's rehabilitation activities in watersheds where this type of additive rehabilitation potential can be demonstrated.

Using the information presented in *Chapter 3: Watershed Conditions*, all of the City's watersheds were evaluated based on these guiding principles, and subsequently assigned to four watershed management strategies under this WMP (Table 4.1 and Figure 4.3). Watersheds assigned to Protection include watersheds and streams that are the most pristine, and least degraded by development in the City of Redmond. Streams in this group have high forest cover with generally intact stream buffers and good stream channel complexity. The highest priority overall management strategy for this group is protection and preservation as few improvements are required to support beneficial uses.

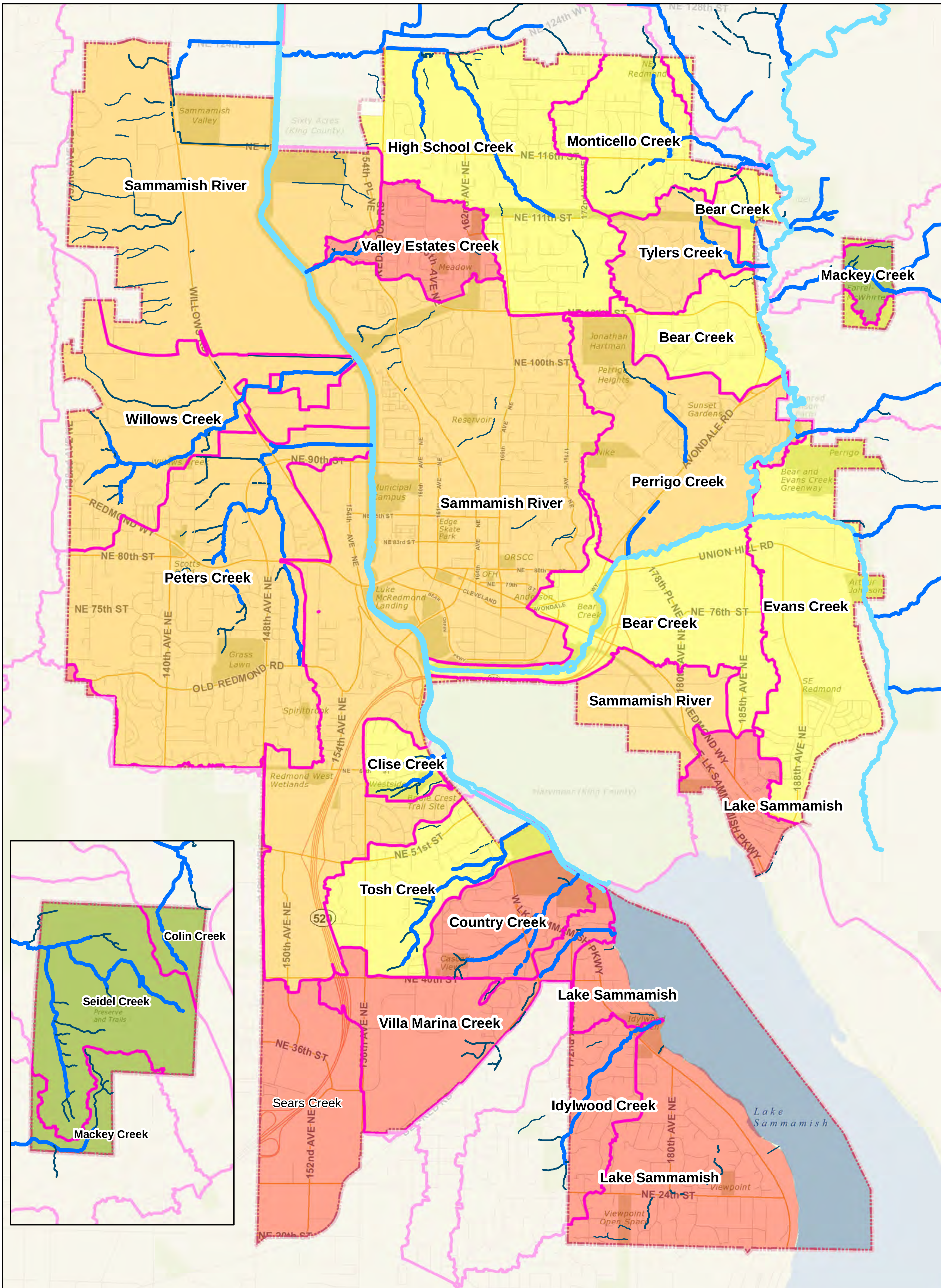

Figure 4.3 - Management Priorities for Watersheds in the City of Redmond

City of Redmond, Washington

11/22/2013

0 0.25 0.5 1 1.5 Miles

City of Redmond WASHINGTON

Legend

- Class I Stream
- Class II Stream
- Class III Stream
- Class IV Stream
- Watershed Boundary
- City Limits
- Protection
- Highest Restoration
- Restoration
- Restoration/Development

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Table 4.1. Management Strategies for Watersheds in the City of Redmond.

Management Strategy	Watersheds	Description
Protection	Colin Creek Mackey Creek Seidel Creek	This management strategy group includes watersheds and streams that are the most pristine, and least degraded by development in the City of Redmond.
Highest Restoration	Bear Creek Clise Creek Evans Creek High School Creek Monticello Creek Tosh Creek	This group includes watersheds with waterbodies that are impaired but have the most potential to support all beneficial uses by implementing watershed rehabilitation measures such as stormwater facility retrofits and stream corridor improvements.
Restoration	Sammamish River Perrigo Creek Peters Creek Tyler's Creek Willows Creek	Watersheds with streams that are more degraded than *Highest Restoration* streams but still have potential to support beneficial uses with substantial investment are included in this management strategy group.
Restoration Development	Country Creek Idylwood Creek Sears Creek Valley Estates Creek Villa Marina Creek Lake Sammamish	Watersheds with streams significantly compromised in both the stream corridor as well as extensive impacts caused by watershed development are in this group. Waterbodies in this category may not be able to fully support beneficial uses in the foreseeable future.

Watersheds assigned to Highest Restoration includes watersheds with waterbodies that are impaired but have the most potential to support all beneficial uses by implementing watershed rehabilitation measures such as stormwater facility retrofits and stream corridor improvements. Although streams may be degraded by development of their associated stream corridors and watersheds, there is significant potential for improving conditions. Water quality is typically good and stream buffers are mostly intact. Salmonid use is typically significant in these streams.

Watersheds that are categorized as Restoration are those with streams that are more degraded than Highest Restoration streams but still have potential to support beneficial uses with substantial investment. Water quality is impaired. Stream corridors are typically only partially intact, and in stream complexity is limited. Salmonid use may be historically significant in these waterbodies, but typically has diminished.

Watersheds assigned to Restoration Development are those with streams that have a significantly compromised stream corridor as well as extensive impacts caused by watershed development. Most of the land cover in these watersheds is either landscaping or EIS. No waterbodies in this management strategy group support significant salmonid use, excluding Lake Sammamish. Streams are currently limited in their potential to provide salmonid habitat and will require substantial improvements. Waterbodies in this category may not be able to fully support beneficial uses in the foreseeable future.

The City's management priorities are largely consistent with the management recommendations from the Puget Sound Characterization. However, based on an evaluation of more site-specific data, the City prioritized additional watersheds for highest restoration including Clise Creek, Evans Creek, High School Creek, Monticello Creek, and Tosh Creek.

4.2 Application of Prioritization

The practical application of the prioritization method described in the previous subsection is outlined below for each major regulatory driver.

4.2.1 GMA Comprehensive Plan

Redmond's Comprehensive Plan is a collection of policy statements defining Redmond's future vision of its natural and built environments. This WMP is intended to assist in the City's plans for future growth by providing a framework addressing existing and new impacts on water resources caused by growth. In particular, this WMP establishes a linkage between the Comprehensive Plan and surface water and stormwater management throughout the City. By doing so, the ultimate goal is to inform City planning activities using a watershed management approach that will result in stream conditions within an urban environment that are safe for human contact and ecologically sound.

The subsections below discuss the key elements of the Comprehensive Plan that will be informed by this WMP to better promote the rehabilitation and protection of the City's waterbodies while accommodating growth.

4.2.1.1 Land Use Planning

Land use planning under the Comprehensive Plan requires the review of drainage, flooding, and stormwater infrastructure when assessing the general distribution and intensity of land uses. This includes an assessment of existing impacts and forecasted impacts to water resources caused by land use actions. In addition, the land use planning element requires an assessment to determine if stormwater infrastructure to accommodate existing and future growth is financially feasible. Prior to the development of this WMP, this assessment was only done through the lens of accommodating additional housing and businesses, and generally did not include detailed assessments of existing water resource conditions, or an in-depth consideration of the diverse impacts of development on water resources.

City development requirements established by the Comprehensive Plan and codified through the City's Zoning Code also require stormwater infrastructure to be constructed on a site-by-site basis as development occurs and establishes critical area designations and associated buffers. Because this site-by-site approach has been largely uncoordinated with broader watershed planning, there are now deficiencies in existing critical areas protection, flow control, and water quality protection that have contributed to water resource impairments throughout the City.

To address these deficiencies, this WMP uses a watershed approach in land use planning to manage "drainage, flooding, and stormwater runoff in the area and nearby jurisdictions" by providing "guidance for corrective action to mitigate or cleanse those discharges that pollute waters of the state, including Puget Sound and waters entering Puget Sound" (RCW

36.70A.070(1)). In general, watershed needs can be accommodated in land use planning by preserving green space, changing density requirements where justified, and addressing stormwater infrastructure on a watershed basis instead of a site-by-site application of requirements. Redmond's Zoning Code and Comprehensive Plan lay the foundation for Redmond's future land use patterns, dictating the fate of environmentally critical areas and important natural resources, as well as managing development impacts on these resources.

To establish the relationship between stormwater, surface water, and land use planning for this WMP, the City developed an estimate of acreage likely to develop or redevelop in each watershed within the City by 2030 (Table 4.2). This information will be used to determine the degree of site-by-site stormwater management that would occur under default regulations compared to what this WMP would deliver using a watershed approach. This analysis will be used by the City to encourage development in the least sensitive areas, encourage protection of high priority areas, and direct stormwater and surface water infrastructure investments where they provide the most benefit.

Table 4.2. Projection of Parcels Likely to Develop or Redevelop by 2030 in the City of Redmond.

Watershed	Square Feet	Acres
Bear	6,425,713	148
Clise	77,062	2
Country	485,145	11
Evans	4,235,168	97
High School	7,160,092	164
Idylwood	303,842	7
Kelsey	3,973,442	91
Lake Sammamish	1,379,468	32
Monticello	4,173,387	96
Perrigo	1,441,918	33
Peters	1,892,685	43
Sammamish River	14,179,852	326
Tosh	992,925	23
Tyler's	309,832	7
Valley Estates	265,656	6
Villa Marina	2,182,931	50
Willows	2,847,952	65
Seidel	0	0
Mackey	0	0
Colin	0	0
Grand Total	54,265,128	1,246

4.2.1.2 Capital Facilities Planning

The Redmond City Council approved Redmond's first Capital Investment Strategy (*Vision Blueprint*) in December 2011. The Vision Blueprint includes transportation projects, fire stations, parks, sewer and water improvements, as well as stormwater and riparian improvement projects. Information used to identify stormwater and riparian capital projects in the Vision Blueprint was also considered during the development or this WMP. However, this WMP is based on a more comprehensive assessment of watershed needs in the City (see *Chapter 3: Watershed Conditions* and this chapter) than the Vision Blueprint. This WMP provides a more holistic assessment of stormwater infrastructure and stream project needs by identifying areas of the City that are currently meeting existing requirements for water resource management, those areas that require improved water resource management, and by prioritizing the types and timing of protection and improvement activities recommended for watersheds. Because this WMP is intended to guide future water resource capital investments, it will be necessary to integrate the Vision Blueprint and WMP in future updates.

In connection with the development of this WMP, the City completed an inventory of existing runoff treatment facilities, including documentation of each facility's stormwater management capacity (area the facility serves). This information is required pursuant to the GMA and is currently not addressed in any of the City's existing stormwater infrastructure planning documents. Data on existing infrastructure design and performance is somewhat limited. Therefore, the City made relatively conservative assumptions regarding the level of runoff treatment a given facility is currently providing (by assuming basic treatment or no treatment for all facilities). The City also inventoried and delineated areas in the City with stormwater flow control facilities. Areas without adequate stormwater flow control facilities are shown in Figure 4.4. Areas in the City without basic runoff treatment are shown in Figure 4.5. Tables 3.1 and 3.2 also provide the area of each watershed areas lacking adequate stormwater control and treatment infrastructure that meets current standards. This includes both public and private facilities, as both influence the ability of the City's stormwater control and treatment infrastructure to protect water resources. Using the information outlined above, combined with the prioritized watersheds and water resource needs outlined in the WMP, future capital facilities planning will focus on opportunities to make the greatest gains in water resource condition for the relative capital investment. While historically this has been the intent, GMA planning has placed the primary responsibility for mitigating stormwater impacts related to development on the developer. This has resulted in construction of stormwater infrastructure generally irrespective of watershed needs. To facilitate more strategic placement of stormwater infrastructure to better manage impacts from future development and redevelopment, the City will review the watershed evaluation and prioritization presented in this and future WMPs to help ensure watershed needs and priorities are addressed. For example, in some areas planned to accommodate the majority of Redmond's future growth, regional stormwater facilities will be planned and constructed. Likewise, stormwater facilities may be preferentially built in watersheds that have large developed areas lacking adequate stormwater management.

4.2.1.3 Transportation Planning

The City's Transportation Master Plan (TMP) is being updated in parallel to the development of this WMP. During development of both plans, efforts have been made to identify opportunities

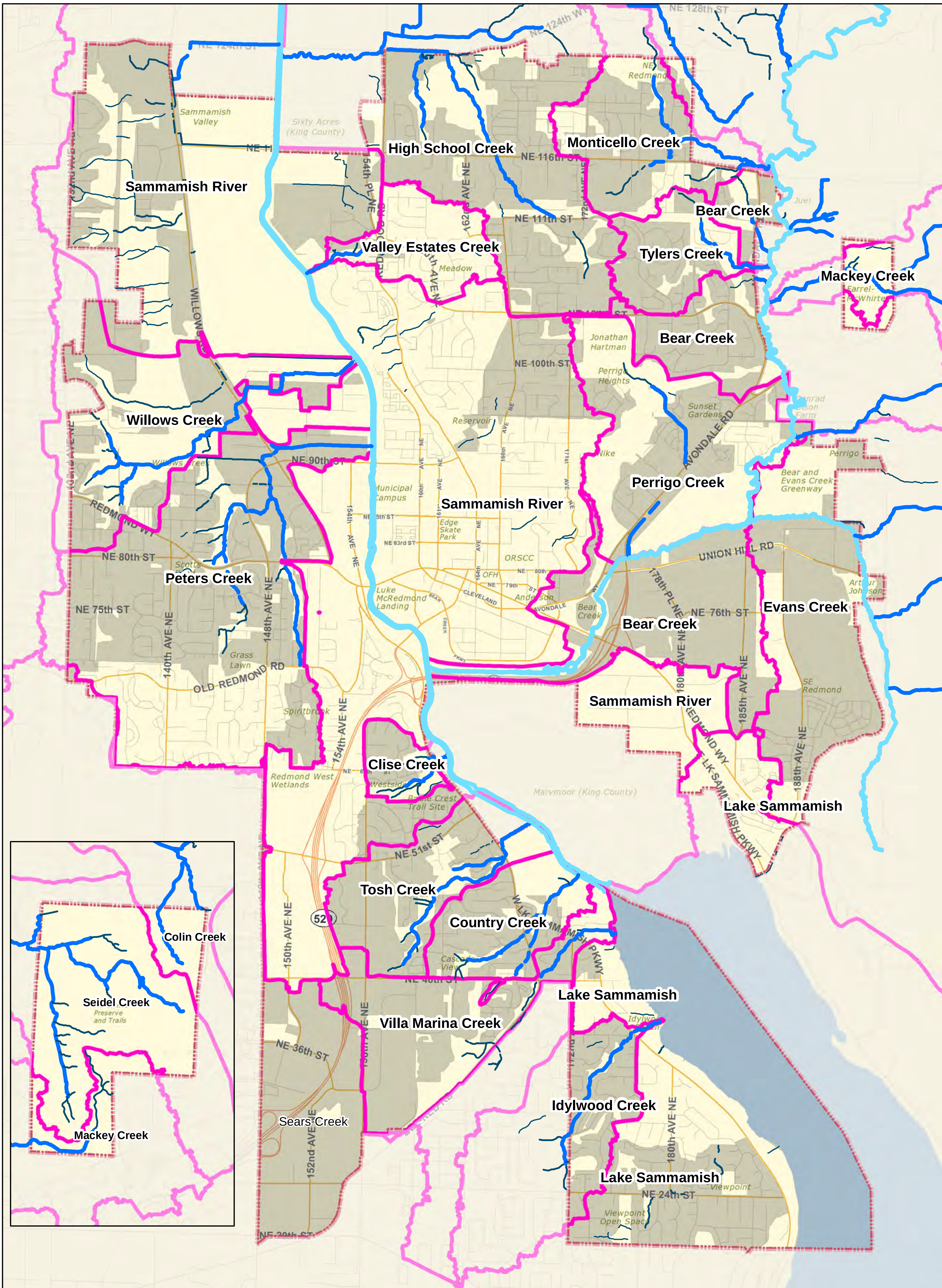

Figure 4.4 - Areas in the City of Redmond Built Without Adequate Stormwater Flow Control

City of Redmond, Washington

11/22/2013

0 0.25 0.5 1 Miles

CityofRedmond WASHINGTON

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Legend

- Class I Stream
- Class II Stream
- Class III Stream
- Class IV Stream
- Watershed Boundary
- City Limits
- Inadequate Flow Control Areas

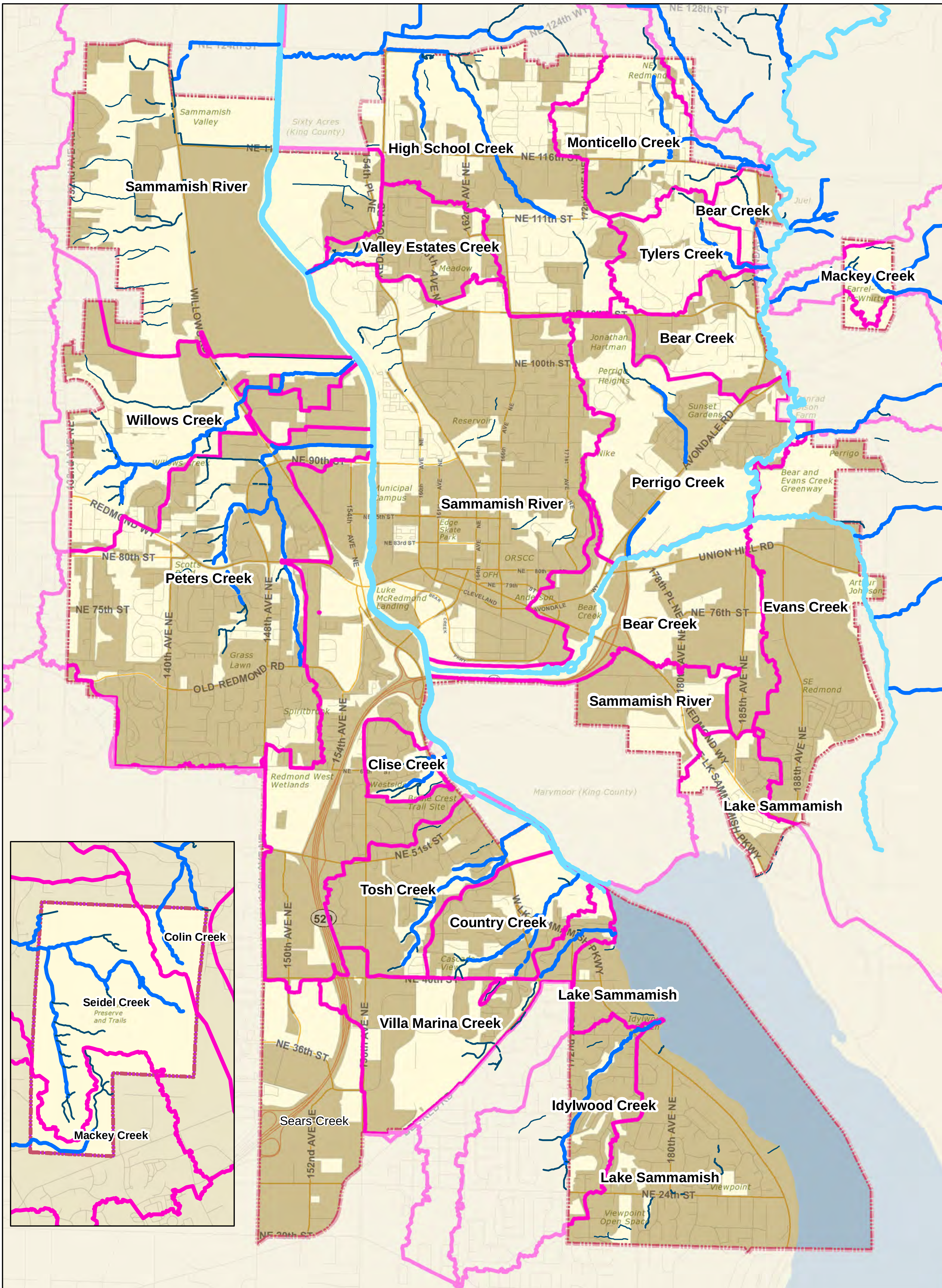

Figure 4.5 - Area in the City of Redmond Built Without Basic Runoff Treatment

City of Redmond, Washington

11/22/2013

0 0.5 1 Miles

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City of Redmond WASHINGTON

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Legend

- Class I Stream
- Class II Stream
- Class III Stream
- Class IV Stream
- Watershed Boundary
- City Limits
- Built Without Basic Treatment

for coordinating their respective goals and activities for mutual benefit. Both aspects of municipal government typically function independently, often resulting in decisions and output unfavorable for both elements. However, the two planning processes impact each other directly, and will benefit from improved coordination.

With guidance from the Puget Sound Regional Council (PSRC), the TMP embodies principles that include "protect and enhance the environment including stormwater runoff (flow rates and water quality) and air quality for both existing and future transportation facilities." In places where roads are being redeveloped, the dense urban environment often limits opportunities to install preferred stormwater management controls. Nonetheless, approximately 30 percent of all Redmond transportation capital funds are designated for stormwater management infrastructure, significantly reducing the number of street projects due to the capital needs for stormwater control. Currently, stormwater treatment and control technologies are constructed within the transportation project prism (typically linear or in expensive vaults underneath the street). This is often not ideal for cost, long-term maintenance, or for improving water resources. Furthermore, stormwater treatment facilities limit the use of the right-of-way for transportation needs (typically the purpose of the transportation project to begin with). This equates to millions of dollars to build non-strategic, difficult to maintain, and often inefficient stormwater controls for city streets.

Transportation planning supports the planned land uses and has the most influence on urban development and redevelopment patterns within the City. Runoff from roads is one of the major sources of water quality degradation regionally and locally. By coordinating activities identified in the TMP with this WMP, water resource improvements such as stormwater retrofit projects can be integrated with needed transportation improvements. At the same time, retrofits of existing roads that incorporate additional stormwater controls can be directed towards watersheds where they will provide the most benefit with coordinated planning.

Using a watershed approach to address existing and future impacts to surface waters associated with roads will be a more strategic and cost effective alternative for protecting and improving surface waters. In addition, roads and associated rights-of-way are distributed throughout the City, providing opportunities to implement strategically located stormwater retrofits in areas where they will provide the most benefit to water resources while limiting land acquisition.

The City has defined three specific areas in which to implement a watershed approach in transportation planning and infrastructure development.

First, using this WMP as a guide, water resource improvements such as stormwater retrofit projects will be integrated with needed or planned transportation improvements. Specifically, the City will review planned or needed transportation improvements to identify areas where stormwater management improvements are also a high priority. This information will be used to evaluate opportunities to either add stormwater improvements to the transportation plans, or increase the priority of the transportation improvements (i.e., for those that can help make gains in water resource conditions). For example, the City is developing guidelines for streets with LID features, to be incorporated into the 2012 Transportation Master Plan update. This includes the use of permeable pavement, bioretention swales, and vegetated dispersion areas where feasible. Guidelines will be established in the TMP for each road functional group, including direction on how to coordinate with this WMP to ensure the LID (or other) stormwater facilities are located where they will have the greatest environmental benefit.

Second, the City will retrofit existing roads (as well as retrofit priority areas adjacent to roads) focusing on areas in Highest Restoration watersheds that are not receiving sufficient stormwater management currently. Roads are distributed throughout the City, allowing for opportunity in almost any watershed to implement targeted stormwater retrofits without having the expense to acquire land. For additional efficiency, retrofitting can occur in conjunction with typical planned transportation maintenance projects including overlays (narrowing the street), pedestrian safety improvements, sidewalk replacement or construction, and non-motorized infrastructure development. Alternatively, retrofits can be installed as independent stormwater projects, capitalizing on available right-of-way to help minimize the cost of land acquisition.

Last, new roads or roads that trigger development and redevelopment requirements for stormwater infrastructure will have the same opportunity as private development to pay into a fee-in-lieu fund to transfer some required stormwater improvements to Highest Restoration watersheds. Refer to the NPDES subsection below for specifics on using a watershed approach to meet stormwater management requirements triggered by development and redevelopment. The City's Transportation Division of the Planning Department will work with the Natural Resources Division of Public Works to find opportunities to use a watershed approach when it is mutually beneficial. Cost savings created by using a watershed approach will be reinvested in additional stormwater infrastructure retrofits for existing roads.

4.2.1.4 Shoreline Master Program

The City's SMP was recently updated and is imbedded within the Comprehensive Plan. As described in *Chapter 2: Existing Regulatory Drivers*, the SMP was developed under the guidelines established by Ecology, and addresses the protection and use of Shorelines of the State located in the City. The jurisdiction of the SMP includes land areas extending 200 feet landward from the from the ordinary high water mark of Bear Creek, Evans Creek, the Sammamish River, Lake Sammamish, and their associated wetlands and floodplains.

The City's shoreline areas provide some of the most valuable natural resources in the community and regionally. In addition, shoreline areas and associated wetlands, floodplains, and aquifers fulfill a vital function in the management of stormwater and water quality. The Shoreline Management Act of 1971 provides the mechanism to protect the public interest associated with the Shorelines of the State while protecting private property rights. The City's SMP categorizes the City's shorelines based on common characteristics into shoreline land use designations that are used to guide allowed uses and provides specific policies designed to protect the ecological functions of shorelines and the species that depend on them.

This WMP will dovetail with the SMP by helping prioritize improvements to shorelines where the shoreline use designation is conducive to preservation and rehabilitation. Policy SL-13 of the SMA calls for a Shoreline Restoration Plan to improve the ecological functions of waters of the state over time. Implementation of the WMP will support that policy goal as well as the overarching SMP goal to achieve no net loss. This WMP integrates shoreline restoration planning with watershed planning. This integration will allow for more opportunities for grant funding of SMP projects, and increase opportunities for coordinating SMP requirements with other regional and local projects.

4.2.2 Clean Water Act

As described in *Chapter 3: Watershed Conditions*, a number of the City's waterbodies are unhealthy for fish and human contact. Waterbodies where water quality data show conditions are unhealthy are identified as Category 5 waterbodies on the state's Section 303(d) list. The City's waterbodies are listed due to high temperatures in summer, low dissolved oxygen concentrations in summer, and high fecal coliform bacteria concentrations year round. Given the prevailing land use patterns within the City, it is likely these problems are widespread and the majority of the City's streams would be placed on Ecology's Section 303(d) list if adequate monitoring data were available. These impairments are common among areas in lowland western Washington with development patterns similar to the City of Redmond.

Under the default approach for meeting CWA requirements, Ecology is required to develop a TMDL study for each Category 5 waterbody on the Section 303(d) list. Currently, the only TMDLs in place in the City are to address water quality impairment in Bear Creek and Evans Creek from high temperatures, low dissolved oxygen concentrations, and high fecal coliform bacteria concentrations (Ecology 2008a, 2008b). As described in *Chapter 2: Regulatory Drivers*, TMDL implementation is a complex process that involves applying the pollution control practices necessary to reduce the pollutant loads to the extent determined necessary in the TMDL. These practices usually consist of point source control permits and nonpoint source control BMPs. The process of completing all these tasks can be extremely time consuming and costly. For example, the existing TMDL for Bear Creek aims to improve Bear Creek's water quality in 50 years.

Based on the above considerations, the City will implement a pollution control program through this WMP for restoring all Category 5 waterbodies that are currently identified on the Section 303(d) list. As described in *Chapter 2: Regulatory Drivers*, this will allow the City to forgo the development of an individual TMDL for these waterbodies. This will be achieved using the watershed approach described in this WMP and will involve coordinating the City's planning activities and other interrelated regulatory requirements into a single strategy for improving water quality. This strategy will yield more immediate results compared to an uncoordinated approach that relies on individual TMDLs for each waterbody; improvements resulting from the TMDL program would take many more years to develop and implement.

Based on guidance that has been promulgated by Ecology (2011b), a pollution control program must meet all seven of the following requirements:

1. Be problem specific and waterbody specific
2. Have reasonable time limits established for correcting the specific problem, including load reduction or interim targets when appropriate

3. Have a monitoring component to evaluate effectiveness
4. Have adaptive management built into the plan to allow for course corrections if necessary
5. Have enforceable pollution controls or actions stringent enough to attain the water quality standard or standards
6. Be feasible, with enforceable legal or financial guarantees that implementation will occur
7. Be actively and successfully implemented and show progress on water quality improvements in accordance with the plan

Requirement 1 in this list will be addressed by implementing pollution control program that will specifically target the primary water quality impairments in the City's streams, which include low dissolved oxygen, high temperature, and high fecal coliform bacteria concentrations. As shown in Table 3.2, 13 of the City's Class II streams are impaired due to one or more of these water quality problems. Given prevailing land use patterns, it is likely that even more of the City's streams are impaired from these constituents but water quality data is lacking. In keeping with the overall objective of this WMP to direct rehabilitation efforts to watersheds where they will provide the most benefit, efforts to improve water quality will initially focus on the Highest Restoration watersheds identified in Table 4.1. Safeguards will also be put in place to prevent further degradation in all watersheds. As individual priority watersheds are rehabilitated, remaining watersheds will be prioritized for improvement through updates to this WMP until all the City's watersheds are no longer impaired (i.e., meet all designated beneficial uses).

In accordance with Requirement 2 in the list above, the goal of this WMP is to rehabilitate all of the City's impaired waterbodies by 2110. Furthermore, an interim goal has been established pursuant to this WMP to rehabilitate all waterbodies associated with Highest Restoration watersheds by 2060. Rehabilitation means that water quality standards will be met in each waterbody, and B-IBI scores will be indicative of *good* (38 to 45) or better habitat conditions.

To meet these goals, an ambient monitoring program, and an adaptive management strategy will be implemented pursuant to this WMP and Requirement 3 above. The monitoring program will be designed to evaluate long-term trends in the City's streams in response to specific management measures for each of the primary sources of water quality impairment. These data will be evaluated every 5 years to ensure acceptable progress is being made towards reducing water quality impairment in the Highest Restoration watersheds, and preventing further degradation in all other watersheds. If acceptable progress is not being made, recommendations for improving this WMP will be developed pursuant to the adaptive management strategy in Requirement 4. More detailed information on these components of the WMP is provided below (see *Chapter 5: Implementation Strategy*).

To meet Requirement 5, the citywide pollution control program will build on in-place TMDL program to address water quality impairment in Bear and Evans creeks. In particular, the following measures to improve low dissolved oxygen concentrations and high temperatures will be implemented in connection with this WMP:

- Plant and maintain trees as well as preserve existing trees to eventually reach the stream system's potential for riparian vegetation along the lengths of all creeks
- Investigate opportunities to enhance groundwater recharge through infiltration where feasible, such as using low impact development practices for new development and redevelopment
- Rehabilitate and protect wetlands in areas that will benefit the stream system and enhance habitat
- Protect cool groundwater and enhance summer base flows:
  - Infiltrate clean stormwater to the maximum extent practicable.
  - Study further the interaction between Bear and Evans Creeks and Redmond's groundwater drinking water source.
  - Restore, protect, and create wetlands in areas suitable for groundwater storage or recharge potential.
- Implement education and outreach programs to minimize human-caused sources of nutrients in the watershed, such as runoff from agricultural fields, and fertilizer from lawn and garden areas, to prevent exacerbating low dissolved oxygen concentrations.
- Connect onsite septic systems to the City's sewer system.

In addition, the following management measures for reducing fecal coliform bacteria concentrations will be implemented in connection with the citywide pollution control program:

- **Source Tracking**:
  - Increase understanding of land uses and animal handling facilities in the watershed
  - Investigate and repair sewer leaks and failing onsite septic systems
  - Identify and eliminate illicit connections to the stormwater drainage system
  - Detect bacteria sources through targeted water quality monitoring
- **Source Controls**:
  - Implement structural (as appropriate) and non-structural stormwater source control BMPs
  - Rehabilitate riparian vegetation to help filter out stormwater pollutants
  - Properly manage domestic animal and livestock wastes

- **Increasing Public Awareness**:
    - Provide outreach and educate the public on local bacteria pollution issues and watershed stewardship

To meet the requirement under Item 6 in the list above, the City will put in place administrative and legal guarantees to ensure the successful implementation of this WMP, including:

- Formal approval and adoption of this WMP by the Redmond City Council
- Reference to this WMP in the City's updated Comprehensive Plan
- Revision of the City's municipal code to make some provisions of this WMP locally codified
- Development regulations

In addition to these guarantees, the City has a well-established Stormwater Utility that is financed with revenue generated by a stormwater utility fee charged to owners of developed property. These fees currently support capital improvement projects for flood control, erosion, conveyance improvements, stream habitat improvements, and regional water quality or detention facilities. This consistent revenue stream will ensure adequate financial resources will be available for implementing this WMP over the long term. Additional information on this revenue stream is provided in *Chapter 6: Implementation Strategy*.

Lastly, as required under 7 in the list above, the City is committed to seeing all its impaired waterbodies rehabilitated. To ensure this goal is met, the City has already identified substantial capital investments for stream rehabilitation and stormwater retrofit projects in its 2013-2018 Stormwater Capital Improvement Plan (CIP) (see more detailed information in *Chapter 6: Implementation Strategy*).

The City and Ecology agree that Ecology will place individual waterbodies into Category 4b once the City has made systematic improvements in the associated watersheds through the implementation of this WMP that address all seven requirements identified above for a successful pollution prevention plan. If Ecology decides to initiate a TMDL study for any Category 4b waterbodies, the City will coordinate with Ecology and others during this process. Finally, if additional Category 5 waterbodies are identified on the Section 303(d) list after this WMP is in place, the City will either coordinate with Ecology to successfully implement a TMDL study or, following the process described above, address the specific impairment through the development of a pollution control program in a subsequent update to this WMP.

In addition to the requirements for rehabilitating Section 303(d) listed waterbodies, anti-degradation provisions of the CWA help prevent unnecessary lowering of water quality, and provides a framework to identify those waters that are designated as an "outstanding resource" by the state (see *Chapter 2: Regulatory Drivers*). Ecology's process for reissuance of the NPDES Phase II permit includes a formal process to select, develop, adopt, and refine control practices for meeting the anti-degradation provisions of the CWA. The next subsection describes the City's approach for meeting the NPDES Phase II permit requirements under this WMP.

4.2.3 NPDES

As described in *Chapter 2: Regulatory Drivers*, the City's NPDES Phase II permit is the primary regulatory driver for stormwater management associated with new development and redevelopment. Among other requirements, the Phase II permit dictates that the City require most new development and redevelopment projects to install stormwater management facilities on-site to help mitigate the water quality and hydrologic impacts of development. In general, these facilities are designed to perform at a level that improves stormwater impacts relative to existing site conditions. For example, runoff treatment facilities may be designed to provide treatment for pollution generating areas that were not receiving treatment before the project (such as existing roads or parking lots). In most cases, flow control facilities must also ensure post-development runoff mimics forested land cover (even when the existing site conditions are more developed). Specific thresholds for determining the degree of stormwater management required on a particular site are provided in Appendix 1 to the NPDES Phase II permit. These thresholds are evaluated based on the type and size of the proposed development. Overall, the default requirement is to mitigate stormwater impacts on-site, and to have stormwater leave the site in a condition that is equivalent to or better than it was before the project.

Through the implementation of this WMP, the City will use an alternative, watershed-based approach to meeting the default NPDES Phase II permit requirements. Rather than meeting all stormwater management requirements for individual projects on-site as described above, the City may allow some stormwater management requirements to be transferred to watersheds prioritized for Highest Restoration (see *Chapter 4: Watershed Planning Approach)*. In isolated situations and subject to siting limitations identified in Appendix B, the City may also allow some stormwater management requirements to be transferred to other locations within the same watershed if that would provide greater benefit. Allowing more flexibility in the siting of stormwater management facilities will result in more strategically placed improvements and investments in stormwater infrastructure that will produce greater benefits in shorter periods (and likely at reduced cost).

There are two key guiding principles for this approach: 1) retain requirements to prevent new impacts from development, regardless of watershed condition or priority, and 2) allow for the transfer of required individual project flow control or runoff treatment improvements to watersheds where they will provide greater benefit.

Principle #1 will be achieved by ensuring that all development projects subject to stormwater management requirements must, at minimum, install stormwater facilities that maintain pre-project conditions. In no case will stormwater runoff from development be allowed to further degrade conditions in any receiving water.

Principle #2 will be achieved by allowing the transfer of individual project-required stormwater management facilities that provide protection beyond pre-project conditions to watersheds where they will provide greater benefit. That is, in-lieu of meeting the NPDES Phase II permit default requirements, an equivalent (or greater) level of improvement that would have been achieved on a given site will be transferred to watersheds prioritized for Highest Restoration. Transfers of stormwater management requirements will only occur when the City has available capacity in an existing City facility, or in a facility that will be completed prior to the project's completion. All transfers of required stormwater management requirements will be tabulated on a *per unit area* basis and include land cover types.

This WMP strategy will have several beneficial outcomes compared to the default NPDES permit requirements for addressing new development and redevelopment. For example, flow control facilities will be built to address existing hydrologic impacts in locations and watersheds where the facility will provide the most benefit to the receiving water. Likewise, strategically placed runoff treatment facilities will address the most significant sources of pollution, thereby creating more meaningful improvements to instream water quality. This approach will ensure no increase in impacts occurs in any watershed while allowing significant improvement in stormwater management compared to the expected outcome from the default NPDES permit requirements.

The City hosted several meetings with representatives from Ecology to vet this approach during its development with positive results. The approach was submitted to Ecology for formal review and a letter of support was received (see Appendix A).

To guide the strategic placement of stormwater infrastructure, the City developed a summary of the acreage in each watershed that is likely to develop or redevelop by 2030 (Table 4.2). Using this information, the City can estimate the acreage of land that will require each stormwater management infrastructure type (e.g., flow control, runoff treatment, LID). This information will be used to plan for the funding and timing of strategically located stormwater management infrastructure for both NPDES compliance as well as the broader capital investment strategy of the Comprehensive Plan.

To be successful, this approach will be implemented through explicit prioritization, clear tracking, and annual reporting. Ongoing monitoring and adaptive management will also ensure the watershed management goals are being met. The specifics of this alternative NPDES Phase II permit compliance strategy are outlined below, organized by the strategies pertaining to flow control, runoff treatment, and LID permit requirements. In each case, the method for meeting NPDES Phase II permit requirements under this alternative strategy is first described followed by the associated tracking and reporting requirements. Detailed flow diagrams outlining the modified methods for meeting NPDES Phase II permit requirements are provided in Appendix B.

4.2.4 Flow Control

4.2.4.1 Method

The default NPDES Phase II permit flow control requirement specifies that most development projects install flow control facilities designed to improve hydrologic conditions relative to existing site conditions sufficient to meet the pre-development standard. The pre-development standard requires that flow control facilities be designed and constructed such that the site replicates the hydrologic conditions of a forest for a range of storms. This requirement to mimic forested conditions is intended to limit further hydrologic impacts from development as well as to compensate for unmitigated historical impacts.

The City's proposed approach will retain requirements to prevent new impacts from development at all sites, but will include the option to transfer some of the required individual site stormwater flow control improvements for development projects to watersheds prioritized for Highest Restoration. Specifically, the City will require that all projects subject to stormwater requirements include stormwater flow control facilities to maintain pre-project hydrologic conditions. However, because most projects would be required under the NPDES Phase II permit default requirements to match pre-developed (i.e., forested) conditions, each project proponent will have the option to pay into a City stormwater fee-in-lieu fund to account for the difference in stormwater management requirements between pre-project conditions and pre-developed conditions. Based on the prioritization method outlined in *Section 4.1 Watershed Management Strategy Prioritization*, the City will apply these stormwater fee-in-lieu funds to construct new flow control facilities in watersheds prioritized for Highest Restoration. Note that the option to pay into the stormwater fee-in-lieu fund will only be made available to the project proponent if there is available capacity in an existing flow control facility, or in a facility that will be completed prior to the requesting project's completion date. Projects that occur in a watershed prioritized for Highest Restoration or on parcels that are currently forested will generally be required to meet the full requirements on-site (see additional guidance in Appendix B).

In all cases, the City will use the stormwater fee-in-lieu fund to manage runoff from an area that is equal to or greater than the development project and a land cover type that is the same or more intensely developed to meet a pre-development forested condition standard.

The method for computing the costs to developers for paying a fee in-lieu of meeting on-site requirements will be determined separate from this WMP. If the project proponent does not choose to pay into the fee-in-lieu fund, they can proceed with on-site flow control improvements that match pre-developed hydrologic conditions.

A simplified hypothetical example of how this approach would work to meet the NPDES flow control requirements is provided below:

- Consider a 22,000-square foot (sq ft) development that consists of an existing parking lot and open area, which will be converted to a multi-story commercial structure. Under existing conditions, 11,000 sq ft of the site is impervious, and 11,000 sq ft is grass. The proposed developed condition is 100 percent impervious cover. Under the NPDES permit default requirements, this development would be required to control stormwater flow to match the pre-developed forested condition for the entire 22,000-sq ft site.

- Under the WMP proposed alternative approach, the project would be required to match pre-project conditions in the watershed where the project is located. That is, 11,000 sq ft of replaced impervious surface (i.e., parking converted to building) would not require additional flow control. The 11,000 sq ft of new impervious (i.e., grass converted to building) would require flow control designed to maintain the pre-project (grass) hydrologic conditions. In most cases, the stormwater facility would be constructed on-site. This would produce post-project hydrologic conditions within the watershed that are equal to the pre-project conditions.

- Under the current default NPDES requirements, the site would normally be required to match a more stringent pre-developed forested condition for the entire 22,000-acre site. However, under the WMP, the project proponent would have the option to pay into the City stormwater fee in-lieu fund to avoid constructing a larger and more costly facilities on-site to match the full pre-developed forested condition. The City would then transfer this required improvement to a City-owned flow control facility in a watershed prioritized for Highest Restoration. This facility would have to manage at least 11,000 sq ft of impervious to a pre-developed forested condition, and at least 11,000 sq ft of grass (or other land cover generating more runoff than grass [e.g., impervious]) to a pre-developed forest condition.

- In reality, the City-owned facilities will likely manage large combinations of contributing area (greater than 22,000 sq ft in this example, and of varying types of contributing area). The City will be responsible for tracking and reporting how much of the stormwater capacity of the City-owned facility is used by each individual site development that pays into the program; see the *Tracking and Reporting* section below.

4.2.4.2 Tracking and Reporting

As noted in the *Method* section above, stormwater management will be provided on-site to maintain existing conditions. Permit required stormwater management that would produce improvements beyond existing site conditions will generally be transferred to a City-owned facility in watersheds prioritized for Highest Restoration. The tracking process will include a record of the stormwater management requirements triggered for each individual development and the management strategy for the site (e.g., 2,000 sq ft of new impervious area managed on-site, 5,000 sq ft of replaced impervious area managed at a designated City facility).

All stormwater fee-in-lieu funds contributed as part of this program will be maintained in a dedicated City fund set up for the purposes of constructing flow control facilities tied to development. Funds will be accompanied by clear records including the following:

- Pre- and post-development project conditions, including areas of new impervious and replaced impervious surfaces; and pre- and post-project forest, pasture, and landscape areas

- Project location (watershed)

- Area and type of surfaces managed

- Degree of stormwater management provided on-site (e.g., impervious managed to what pre-development condition)

- Hydrologic performance of on-site BMPs

- The specific allocation of funds to a flow control project in a priority location, including equivalent area and the hydrologic performance standard that was matched

The City will perform hydrologic modeling of all new City-owned facilities to clearly identify the size and type of area managed and document the method used to size a facility and resultant hydrologic performance. Likewise, as each new development project pays into the City-owned facilities, the City will track the area of each site that is participating to make sure the WMP approach manages equal or more area of the same, or more developed land cover types than the default NPDES permit requirements.

For crediting and tracking purposes, four target land cover types will be used: forest, pasture, lawn, and impervious. Whenever feasible, the type of area managed to offset development will be of the same or more intense land cover type as the pre-project site (e.g., managed lawn should be used to offset a lawn to impervious conversion at project site). Alternatively, the same area of a more developed land cover type than the pre-project site condition would be managed to ensure that the project provides equal or greater benefit to the receiving water body.

At a minimum, this information will be reported annually as part of the City's NPDES permit annual reporting requirements.

4.2.5 Runoff Treatment

4.2.5.1 Method

Somewhat similar to the flow control methods outlined above, the NPDES Phase II default permit requirements specify that most development projects install runoff treatment facilities designed to maintain or improve stormwater runoff conditions relative to the pre-project conditions. Like the flow control approach, the City's proposed approach for runoff treatment will retain requirements to prevent new impacts from development at all sites, and transfer runoff treatment improvements to strategic locations within a watershed prioritized for Highest Restoration. The main distinction between the runoff treatment and the flow control approaches is that the runoff treatment approach is contingent on the type of treatment required (such as basic or enhanced) and the distinction between new and replaced pollution generating hard surfaces (PGHS) and pollution generating pervious surfaces (PGPS).

Specifically, for projects triggering oil control, the City will require those projects to install an oil control facility on-site. Additionally, sites that trigger enhanced or phosphorus treatment will be required to construct the required facilities on-site. The application of this WMP is limited to areas that trigger basic treatment requirements.

In the event the site triggers basic treatment requirements, these requirements may be transferred following the same principles as outlined for flow control, including retaining requirements to prevent new impacts from development and the option to transfer some of the required individual site stormwater runoff treatment improvements for development projects to other strategic locations within a watershed. Specifically, for all new PGHS and PGPS, the City will require on-site runoff treatment facilities that satisfy basic treatment requirements. For projects that replace existing PGHS or PGPS that is not managed by an up-to-date existing runoff treatment facility, the project proponent would have the option to pay into the City stormwater fee-in-lieu fund to avoid providing on-site treatment for these areas. These treatment requirements would then be transferred to an appropriately located City-owned facility in a watershed prioritized for Highest Restoration.

Additionally, if the project generates less than 5,000 sq ft of new PGHS and PGPS (below Ecology thresholds for treatment), but the project will replace PGHS and PGPS and the value of the proposed improvements necessitate treatment for both new and replaced surfaces, the treatment requirements for the new PGHS or PGPS may be transferred with the requirements for replaced surfaces, as described above (see additional guidance in Appendix B).

Note that projects located in a watershed prioritized for Highest Restoration or on parcels that currently receive runoff treatment will generally be required to meet full treatment requirements on-site (see additional guidance in Appendix B).

In all cases, the WMP strategy will require that City-owned facilities manage runoff from an area or land use with a higher pollution potential relative to the land use treated by an on-site facility. For determining pollutant potential, the following land uses are prioritized in descending order: high use streets, industrial, commercial, multifamily, low use streets, high-density residential, medium-density residential, and low- and rural-density residential. By applying these requirements, the City will prevent any increase in water quality impacts resulting from development in the watershed where the project will occur, and allow for flexibility to retrofit other areas that have a higher pollution potential.

As with the flow control method, the costs to developers for paying a fee in-lieu of meeting on-site runoff treatment requirements will be determined separate from this WMP. However, the requirement will be that the City mitigate an equal or greater contributing area than that impacted by the development, that the contributing area be of equal or greater pollution generating potential as the development project, and that the City facilities perform at a level equal to or greater than what would have been required to be installed on-site for the development project.

Three simplified hypothetical examples are outlined below:

- **Example #1** – Consider a hypothetical 10,000-sq ft existing vacant lot that is entirely non-pollution generating grass. The proposed project is to convert the grass lot to a parking lot (PGHS). Because this project represents an increase in water quality impacts on-site, the project will be required to install a runoff treatment facility onsite for the entire PGHS area.

- **Example #2** – Consider a hypothetical 10,000-sq ft parking lot that is entirely PGHS, but that includes functioning runoff treatment facilities under existing conditions. The proposed project would completely replace the existing lot with more parking (an unlikely project in reality, but used for illustrative purposes). Because the site includes runoff treatment facilities under existing conditions, the project will be required to install runoff treatment facilities that meet current treatment standards for the entire on-site PGHS area. This requirement would prevent any increases in water quality pollution.

- **Example #3** – Consider a hypothetical 10,000-sq ft existing parking lot that is entirely PGHS, but that has no runoff treatment facilities under existing conditions. The proposed project would completely replace the existing lot with more parking. Because this site does not include runoff treatment facilities under existing conditions, the project could pay a fee to the City in-lieu of installing runoff treatment facilities on-site. This would result in no increase in water quality impacts from the site, as there is no treatment under existing conditions, and would allow the City to transfer the required runoff treatment to a watershed prioritized for Highest Restoration.

This approach allows the City to manage runoff quality on a watershed basis by strategically locating runoff treatment facilities that address the highest priority areas (from a water quality perspective), thereby creating improved load reductions relative to the default NPDES permit requirements for site-by-site runoff treatment.

4.2.5.2 Tracking and Reporting

Because new PGHS must be managed on-site, the primary focus of the tracking mechanism for runoff treatment will focus on replaced PGHS areas. All fee-in-lieu funds contributed as part of this program will be maintained in a dedicated City fund, set up to tie runoff treatment to development. Funds will be accompanied by clear records including the following:

- Pre- and post-development project conditions, including new and replaced PGHS
- Project location (watershed)
- Area managed on-site
- Water quality performance of on-site facilities, if any (such as basic, enhanced, or phosphorus control)
- The area managed and the water quality performance required by the default NPDES permit
- The specific allocation of funds to a runoff treatment project in a priority watershed, including area, pollution-generating characteristics, and the water quality treatment performance standard that was matched

At a minimum, this information will be reported annually as part of the City's NPDES permit reporting requirements.

4.2.6 Low Impact Development (LID)

4.2.6.1 Method

Ecology's NPDES requirements specific to LID (i.e., Minimum Requirement #5 of Appendix 1 of the NPDES Phase II permit) will not take effect until January 1, 2017. For the purposes of this WMP, the City has developed a watershed based approach for implementing LID requirements within the City after this date. In general, the City proposes to approach Minimum Requirement #5 of the permit similar to Minimum Requirement #7 (flow control, previously discussed). The main difference is that Minimum Requirement #5 allows projects to use either a quantitative performance standard (like the approach to meeting the flow control requirements), or alternatively one of two prescribed lists of LID BMPs per the NPDES Phase II permit. However, only the LID performance standard will be used when transferring LID-related requirements to other sites. Areas subject to LID controls are tracked by the area generating runoff that is controlled by LID, similar to the tracking for flow control and runoff treatment areas.

The NPDES Phase II permit requirements essentially specify that smaller development projects (i.e., those only subject to Minimum Requirements #1 through #5) must meet the LID performance standard, or consider a prescribed, prioritized list of LID BMPs (List #1 in the permit) and apply feasible LID BMPs to all new and replaced hard surfaces. Larger projects (those subject to Minimum Requirements #1 through #9) must either meet the LID performance standard, or apply a more stringent BMP list (List #2 in the permit) relative to the list for smaller development projects.

The City's watershed approach as it relates to MR #5 will only be applicable to public projects. Private development will be required to follow the NPDES permit default requirements. The City's approach is as follows:

- The City will encourage the use of LID techniques on all sites, especially at sites with outwash soils.
- For public projects that occur in watersheds prioritized for Highest Restoration, those projects will be required to meet the full NPDES permit LID requirements on-site if LID is determined to be feasible (i.e., apply LID BMPs to new and replaced PGHS on-site where feasible, or design LID BMPs to meet the LID performance standard). Alternatively, an equivalent amount of area may be retrofitted with LID in the same watershed if 1) it provides equal or greater benefit to the receiving water, 2) the alternate facility discharges runoff within 1/4 mile downstream or anywhere upstream of the project site, and 3) LID is more feasible on the alternate site than the project site.
- For public projects outside watersheds prioritized for Highest Restoration, public projects will either meet the full NPDES permit LID requirements on-site if LID is determined to be feasible (i.e., using either the mandatory lists or meeting the performance standard, as applicable), or retrofit the same amount of area in a watershed prioritized for Highest Restoration. All LID requirements that are transferred to a priority watershed will be designed to the LID performance standard and not rely on using the mandatory lists. Note that these transfers will also only occur if the project is subject to Minimum Requirements #1 through #9.

4.2.6.2 Tracking and Reporting

Similar to the flow control and runoff treatment tracking and reporting, all fee-in-lieu funds contributed as part of this program will be maintained in a dedicated City fund set up for the purposes of LID implementation tied to development. Funds will be accompanied by clear records including the following:

- Pre- and post-development project conditions including new and replaced hard surfaces

- Project location (watershed)
- Area that meets Minimum Requirement #5 on-site, including record of whether the performance standard or a prescribed list was used
- The resultant gap in replaced hard surface area managed relative to the default permit requirements
- The specific allocation of funds to a LID project in a priority location, including the equivalent area and the hydrologic performance standard that was matched

At a minimum, this information will be reported annually as part of the City's NPDES permit annual reporting requirements.

4.2.7 WRIA 8 Salmon Recovery Plan

As described in *Chapter 2: Regulatory Drivers*, CSCP lays out a 10-year strategy for the protection and recovery of Chinook salmon. It specifically states, "Local governments and other WRIA 8 partners can make the most impact on habitat where salmon spawn and rear, particularly through implementation of land use and stormwater management policies and programs, local protection and rehabilitation projects, and public involvement opportunities." Clearly, Chinook recovery efforts go hand in hand with watershed planning. In fact, the programs and priorities laid out in the CSCP largely parallel the programs and priorities driven by other regulations (e.g., GMA, CWA, and NPDES). Since the CSCP is already developed, the goal of this WMP will be to integrate findings and recommendations from the CSCP into the overall watershed planning strategy.

As described in *Chapter 3: Watershed Conditions*, the Class I streams in the City have been assigned Chinook use categories (e.g., core, migratory, satellite) based on relative watershed conditions and Chinook abundance and use (LWCS/WRIA 8 2005). These assignments and other findings (e.g., presence of fish barriers) detailed in the CSCP were used as part of the supporting framework for prioritizing watersheds for rehabilitation in this WMP. Specific actions listed in the CSCP for individual streams will be tied to the City's GMA planning framework through this WMP. In this way, and through the WMP's emphasis on prioritizing and optimizing activities where they will achieve the greatest benefits for water quality and habitat improvements, the overarching goal of salmon recovery efforts will be better met.

The following is a generalized summary of goals from the CSCP followed by an explanation of how they will be addressed through the implementation of this WMP.

The following four goals that specifically relate to hydrologic processes and stream flow were identified in the CSCP:

1. Identify and protect headwater areas, wetlands, and sources of groundwater (e.g., seeps and springs) to maintain natural hydrologic processes and temperatures that support Chinook.
2. Protect and restore forest cover, soil infiltrative capacity, and wetlands, and minimize increases in impervious surfaces, to maintain watershed function and hydrologic integrity (especially maintenance of sufficient base flows).

3. Investigate and address the impact of surface water and groundwater withdrawals on flow conditions.

4. Provide adequate stream flow to allow upstream migration and spawning by establishing instream flow levels, enforcing water rights compliance, and providing for hydrologic continuity.

To assist with goals 1, 2 and 4, the City will update its stormwater code to adopt LID techniques by the end of 2016 consistent with Ecology's NPDES requirements. In addition, the City will continue to pursue and encourage retrofit projects such as was recently designed for Overlake Village. Stream buffer requirements and tree planting goals associated with the City's Comprehensive Plan will assist with goals 1 and 2 by providing additional stream shading that will lower stream temperatures, and increase dissolved oxygen during critical seasons. The City's plan to meet the flow control requirements of the NPDES Phase II permit will ensure that existing hydrologic processes are maintained in most parts of the City and improved (as compared to existing conditions) in priority watersheds providing support for Goal 1. Finally, base flows in streams will be maintained or increased by emphasizing LID practices for managing stormwater pursuant to the requirements of the NPDES Phase II permit (see *Section 4.2.3 NPDES*) to help achieve Goal 4.

The following two goals were identified in the CSCP to protect water quality:

1. Protect and restore water quality from fine sediments, metals, high temperatures, and bed scouring high flows.

2. Adverse impacts from nonpoint source pollution (particularly street runoff) should be prevented through stormwater BMPs and minimization of number and width of roads.

These goals will be largely met through the WMP application of the NPDES Phase II permit that will require stormwater treatment for all new development and most redevelopment (see preceding NPDES subsection). Due to these provisions, stormwater quality will generally improve throughout the City as additional stormwater runoff treatment is progressively provided in areas of the City that currently receive none. Through the transfer of these stormwater treatment requirements to priority watersheds, additional treatment (e.g., removal of metals) can be achieved in those areas where it is more likely to provide the most benefit. As noted above, tree planting goals associated with the City's Comprehensive Plan will also result in additional stream shading that will lower stream temperatures. Finally, the City intends to comply with Special Condition S5.C.4.f of the NPDES Phase II municipal stormwater permit which requires LID to preferred and commonly used approach to site development; this will provide additional opportunities to improve hydrology and water quality.

The following three goals were identified in the CSCP to protect or rehabilitate habitat:

1. Protect and restore floodplain connectivity and increase off-channel habitat by minimizing street crossings, reducing channel confinement, and removing floodplain structures.

2. Protect and increase channel complexity, including large, woody debris, which contribute to channel stability and development of pools, trap sediment, and reduce water temperature.

3. Protect and restore riparian function, including revegetation, to provide shade and reduce water temperatures, provide sources of large woody debris to improve channel stability and contribute to pool creation.

These goals will largely be met through site-specific rehabilitation projects that are identified for the priority watersheds. In addition, tree planting that occurs within the riparian recruitment zone should ultimately result in more large woody debris recruitment over the long term. Finally, the City's SMP and Critical Areas Ordinance provides for protection of riparian buffers. Through such protection measures, along with projects to provide invasive plant control and tree planting, the City's riparian buffers will provide more natural functions to the shoreline and improve overall habitat conditions.

Chapter 5 Watershed Needs Assessment and Rehabilitation Strategies

- **A science-based method is used to assess watershed needs based on a hierarchical model of stream functions within a watershed.**
- **Based on the watershed needs assessment, a spectrum of tools is identified to rehabilitate and preserve stream and watershed ecological functions.**
- **For each watershed management strategy category, specific activities, including preservation where appropriate, are identified to improve stream and watershed conditions.**
- **Recommended rehabilitation strategies are consistent with regional initiatives for salmon recovery as well as local planning efforts.**

Building on the information presented in *Chapter 4: Watershed Planning Approach*, this chapter outlines the science based method used to assess watershed needs, and identifies the spectrum of tools that are available to rehabilitate and preserve stream and watershed ecological functions. Based on the results of the needs assessment, overall rehabilitation strategies are discussed for each watershed management strategy category; specific activities, including preservation where appropriate, are also identified to improve stream and watershed conditions.

5.1 Watershed Needs Assessment

The purpose of the watershed needs assessment is to direct rehabilitation and preservation activities within each watershed management strategy category so they are targeted to the most effective activities given the land uses, geomorphic conditions, and habitat quality (discussed in detail in *Chapter 3: Watershed Conditions*). In addition, the needs assessment takes into account other local and regional ongoing efforts to improve watershed functions, such as WRIA 8 salmon recovery efforts, and the Regional Facilities Plan for the Downtown and Overlake subwatersheds. The overall management strategy is intended to accelerate achievement of performance goals for the Plan while ensuring the greatest cost-benefit for the City's efforts.

Watershed needs were assessed using a hierarchical model of stream functions within a watershed. The approach builds on the knowledge that stream channel rehabilitation will require substantially greater effort if conducted in highly impacted watersheds with altered sediment budgets and a flashy hydrologic regime (Roni et al. 2002). Stream channel rehabilitation is most effective in watersheds that have a natural hydrograph and minimal sediment loading (Suren and McMurtrie 2005). In addition, because the condition of a watershed will dictate reach scale dynamics within a stream channel, a watershed based approach is a critical component to successful rehabilitation of streams.

5.1.1 Science Review

Structural complexity in streams is naturally provided by large wood, root wads, and boulders, and promotes habitat complexity and healthy ecological functions. Often these features are added to degraded streams to rehabilitate stream habitat; however, the stability of these added structural features is influenced by hydrologic conditions in the watershed. For example, a study by Frissell and Nawa (1992) examined 161 structures placed in 15 streams in southwest Oregon and Washington after flooding events that ranged from a 2- through 10-year recurrence interval. They found that 60 percent of the structures had failed and even caused damage to the streams where they were located. Roper et al. (1998) found instream structures to be effective under certain circumstances. In their study of 3,946 structures placed in 94 streams across the Pacific Northwest, they found that 80 percent of the monitored structures were stable and functioning as designed. However, the majority of these structures were built on the channel margin in low-order streams.[1] When analyzing structures that were placed directly in the channel, and structures that were placed in large rivers, they found that the failure rate on average exceeded 50 percent and was as high as 83 percent. In summary, most research indicates that instream structures are more likely to fail in large rivers (Roper et al. 1998), high energy environments (Frissell and Nawa 1992), and when sediment loading is elevated (Frissell and Nawa 1992; Suren and McMurtrie 2005).

These studies suggest a harsh reality where stream rehabilitation is least likely to succeed in those stream reaches that are most degraded. Streams with flashy hydrographs caused by watershed deforestation or urban development, and streams with high sediment loads from anthropogenic disturbance in the watershed are typically the degraded systems where rehabilitation is focused; however, they are also the systems where rehabilitation goals are least likely to be achieved. As a result, the recommendation from this review is to focus in-channel stream rehabilitation on those channels that have a more natural hydrograph and average sediment loading. In more heavily impacted stream systems, the recommendation is to improve watershed hydrologic conditions before instituting stream rehabilitation measures to ensure effective results (Roni et al. 2002).

5.1.2 Stream Functions Model

Figure 5.1 presents a Stream Functions Pyramid model prepared by Harman (2009) which, along with the hierarchical approach discussed above, was used to guide the selection of rehabilitation tools and locations proposed in this plan. The ultimate goal is to increase stream and riparian biological diversity and sustainability (located at the top of the pyramid); however, this is attainable in the long term only by first addressing the lower levels of the pyramid. The intention of the pyramid is to show the dominant cause and effect relationships.

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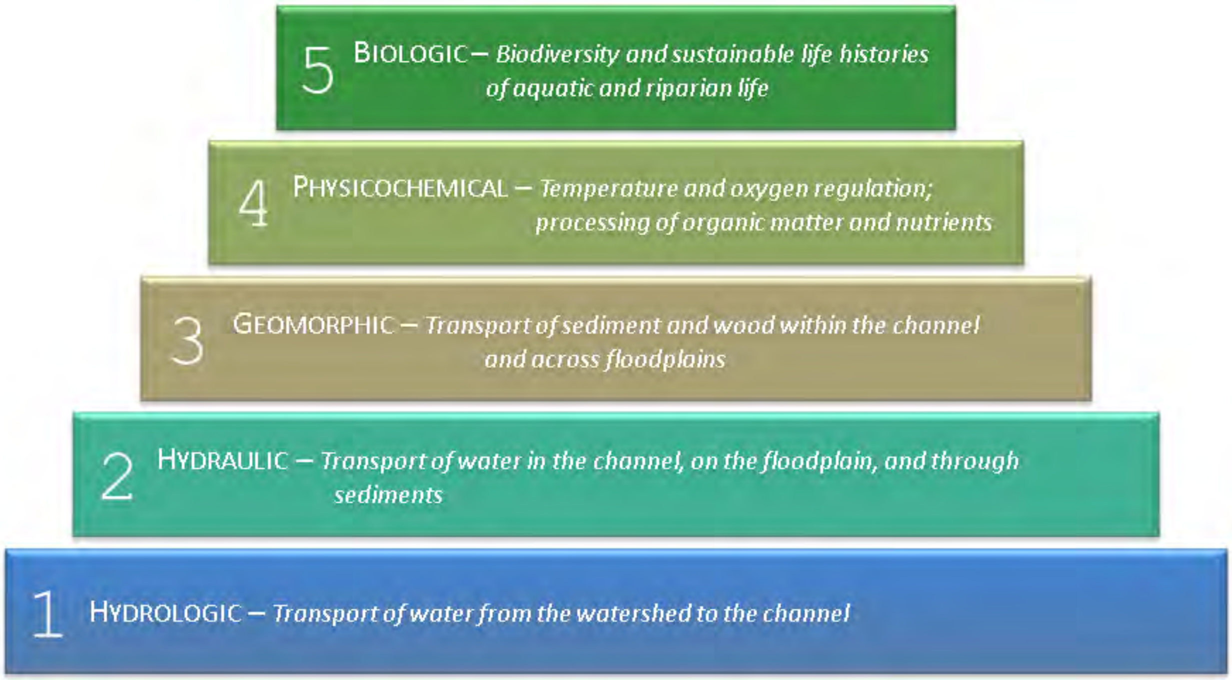
[1] A low order stream is a stream that does not have any, or has very few streams feeding into it.

In general, biodiversity is dependent on habitat structure and quality, which are dictated by the lower levels of the pyramid beginning with hydrologic conditions.



Adapted from Harman (2009)

Figure 5.1. Stream Functions Pyramid.

Hydrologic conditions in the form of flow quantity and intensity are the primary drivers of stream channel form. Hydraulics follows by dictating reach-scale form and floodplain connectivity. Although hydraulic functions are closely related to geomorphic functions; for example sinuosity associated with geomorphic functions affects channel slope, channel slope in turn affects stream velocity, which is a hydraulic function. Still the dominant characteristics of hydraulic functions support geomorphic interactions of sediment and wood, and with channel hydraulics produce the formation of aquatic habitat. Aquatic habitat quality is then dictated by physicochemical parameters such as dissolved oxygen, temperature, and the processing of organic matter, nutrients, and pollutants. Finally, the organisms themselves are on the pyramid top because they fundamentally rely on each of the building blocks of the pyramid.

Rehabilitation strategies that address parameters at the top of the pyramid without first improving conditions near the bottom of the pyramid have a high likelihood of failure. For instance, stocking fish in a heavily polluted and degraded stream would address step 5 in Harman's pyramid before steps 1 through 4, and will result in high fish mortality and a negligible improvement to the aquatic biota. Conversely, a more sustainable and effective approach would focus on addressing each of the steps in the pyramid. As an example, implementing LID or flow control in the watershed would improve hydrologic functions; construction of a high-flow bypass would benefit hydraulic functions; geomorphic functions would be improved through the installation of rock weirs and large woody debris; and finally physicochemical functions would be enhanced through improved water quality treatment, and by increasing vegetation in riparian areas. Once measures such as these are taken, fish that make their way into the resulting channel habitat would have a much greater chance of thriving.

Although the research indicates that much of the stream channel work in the Pacific Northwest has underperformed (Frissell and Nawa 1992; Roper et al. 1998), it also suggests that if practitioners address hydrology and hydraulics prior to conducting stream channel work, projects will be successful. This plan acknowledges these findings and, consequently, used the Stream Functions Pyramid and supporting research to inform the watershed management strategy categories presented in Chapter 4, and to select the most effective rehabilitation tools for each watershed as discussed in this chapter.

5.2 Rehabilitation Tools

A spectrum of tools targeted to improving watershed management and stream functions is provided in Table 5.1. The tools include project activities such as removing a fish barrier, maintenance programs such as increased street sweeping, preservation initiatives like tree retention, and public outreach and education programs that could include addressing pet waste, and herbicide and pesticide use as examples. The tools are organized and color coded based on the function they most directly support in the Stream Functions Pyramid (see Figure 5.1). Later discussions of each watershed management strategy category identify the specific rehabilitation tools to be used to address watershed needs in tables and on maps specific to each watershed. The tables identify the rehabilitation tools selected from Table 5.1 considered to be the most effective for that watershed, and the figures provide the general locations where the rehabilitation tool will be used. Note that many tools benefit functions in more than one layer of the pyramid. Also, actions do not need to strictly follow the recommended order to deliver improvements to the watershed.

The following narrative, and the accompanying figures and tables constitute the current implementation strategy for improving each of the City’s watersheds.

5.3 Watershed Rehabilitation Strategies

The Stream Functions Pyramid model was used as the primary basis for assessing watershed needs, and for recommending the general rehabilitation strategies identified for each watershed. Based on the recommendations, specific watershed and stream rehabilitation tools from Table 5.1 are identified for implementing the rehabilitation strategies. The tools were selected specific to conditions found within each reach of the watershed, which is a water course segment that has a similar context and condition. Reaches were delineated within each watershed based on geomorphic conditions, land use within the watershed, and the condition of buffers.

In addition, regional initiatives for salmon recovery along with a number of City planning documents were reviewed to ensure that rehabilitation strategies were consistent with regional and local planning efforts. This review included the following plans:

Table 5.1. Watershed and Stream Rehabilitation Tools.						
		Watershed Function				
		Highest Priority-------------→-------------→------------→---------------→-------------Lowest Priority				
Rehabilitation Tool	Rehabilitation Tool Description	1 – Hydrologic	2 – Hydraulic	3 – Geomorphic	4 – Physiochemical	5 – Biologic
1. Construct or Retrofit Stormwater Flow Control Facilities	Install flow control facilities that reduce the existing hydrologic disruption. Green infrastructure and infiltration facilities (e.g., rain gardens, permeable pavement) are preferred over grey infrastructure (e.g., detention vault, wet ponds). Design will result in stormwater discharges matching predeveloped discharge rates from 50% of the 2-year peak to the 50-year peak flow.					
2. Construct or Retrofit Stormwater Infiltration Facilities	Retrofit developed areas to reduce the quantity of runoff. Retrofitted areas allow for some water to infiltrate, evaporate, and/or be transpired by vegetation. Examples include downspout disconnection programs, voluntary rain garden program, and right-of-way bioretention installations. Bioretention design will result in stormwater discharges post development matching predeveloped discharge rates from 8% of the 2-year peak to 50% of the 2-year peak flow.					
3. Change Zoning Code	Adopt revised land development standards or zoning code that minimizes the loss of native vegetation and the creation of impervious surfaces through increased natural area set asides. Included are street standards, land use setbacks, lot circle size, and lot clustering.					
4. Protect and Increase Forested Areas in the Watershed	Plant trees and protect existing trees from removal to increase the overall tree canopy in the watershed and improve hydrologic functioning.					
5. Increase Flow Control Facility Inspections	In addition to NPDES permit required stormwater facility inspections, inspect, and require maintenance/cleaning of private flow control facilities not designed to current standards. Increase inspection frequency of both public and private facilities if facility frequently requires cleaning during permit required inspections.					
6. Add Side Channels	Design and install side channels that can be used by fish for foraging and for refuge during storm events. Side channels should be designed to provide diversity in aquatic habitat.					
7. Relocate and/or Reconnect Creek, Tributaries, Riparian Wetlands, Floodplain	Reconnect historically connected off-channel hydrologic features, such as wetlands, floodplains, and side channels to provide additional aquatic habitat and flood attenuation.					
8. Construct High Flow Bypass	Design and install a high-flow bypass to limit stormwater flows to the design volume of a facility or to reduce erosive energy to a stream.					
9. Re-grade Banks	Reduce the slope of the channel banks to provide additional channel storage, reduce high velocity flows, and increase habitat diversity.					
10. Re-meander Creek Channel	Recreate meandering creek channel segments that are currently straightened/ditched in order to create additional in channel habitat with a dynamically stable channel form.					
11. Add Instream Complexity	Add pools, large woody debris, and other features to existing creek channels that are lacking a diversity of habitats and can no longer accommodate biological complexity.					
12. Supplement Instream Gravel	Add gravel to the creek channel to create spawning substrate and higher quality habitat for primary and secondary production.					
13. Stabilize Banks	Use bioengineering techniques to stabilize currently eroding banks. Applied either for infrastructure protection and/or for stabilization of cut banks that are acting as problematic sediment sources.					
14. Add Grade Control	Add wood and/or rock to the channel to reduce the slope of the water surface and consequently increase sediment deposition and habitat complexity while discouraging scour and incision.					
15. Perform Pollutant Source Control Inspections	Inspect businesses, including multifamily rental properties, providing technical support to assist property owners reduce the amount of pollution entering stormwater systems, surface waters, and groundwater. Techniques may include pesticide/fertilizer reductions, secondary containment of chemicals, and operational changes that will reduce pollution.					
16. Clean Streets	Focused and increased frequency of street sweeping efforts to reduce pollution from high use streets and streets adjacent to industrial and commercial land uses.					

Table 5.1 (continued). Watershed and Stream Rehabilitation Tools.						
		Watershed Function				
		Highest Priority-------------→-------------→-------------→---------------→-------------Lowest Priority				
Rehabilitation Tool	Rehabilitation Tool Description	1 – Hydrologic	2 – Hydraulic	3 – Geomorphic	4 – Physiochemical	5 – Biologic
17. Construct or Retrofit Stormwater Runoff Treatment Facilities	Install runoff treatment facilities (e.g., filters, bioretention). Green infrastructure and infiltration facilities are preferred over grey infrastructure because they reduce runoff volume in addition to providing treatment (see tools 1 and 2).					
18. Provide Education & Outreach	Develop educational material and perform outreach efforts, such as presentations at community meetings, to educate residents about water quality, habitat, and stormwater issues within their home watersheds.					
19. Track Pollution Sources	Use in-field and/or lab testing to trace pollution in stormwater conveyance back to the source of the pollution. Once located, control source as appropriate, such as require structural or operational source control measures.					
20. Restore Buffers	Perform significant buffer restoration utilizing heavy equipment and planting canopy forming trees, groundcovers, and shrubs.					
21. Enhance Buffers	Weed removal, light planting					
22. Increase Runoff Treatment Facility Inspections	Increase inspection frequency of both public and private stormwater runoff treatment facilities if facility frequently requires cleaning during routine NPDES permit required inspections.					
23. Ecology Permitted Site Support	Work with state permitted sites to annually review their SWPPP and pollution prevention measures, to provide technical support, and potential cost saving solutions. Work will not result in enforcement actions by the City for state permit compliance. Alternatively, efforts will focus on providing support to achieve permit requirements.					
24. Remove Fish Barriers	Remove in-channel barriers to fish migration.					

- **WRIA 8 Chinook Salmon Conservation Plan (LWCS/WRIA 8 2005)** – recommends actions to restore and protect habitat that salmon need to survive in the Lake Washington/Cedar/Sammamish Watershed. The intent of the plan is to lead the region toward a legacy of healthy, harvestable salmon and improved water quality for future generations. Watershed priorities include protecting forests, reducing impervious surfaces, managing stormwater flows, protecting and improving water quality, conserving water, and protecting and restoring vegetation along stream banks.

- **Redmond's Regional Facilities Plan for the Downtown and Overlake Subwatersheds** – Includes projects aimed at improving water quality and hydrology in the Sammamish River, Bear Creek, and Kelsey Creek.

- **6-Year Stormwater Capital Improvement Plan** – This document identifies projects needed to alleviate problems caused by existing development, as well as to prevent future problems that could result from planned development. The projects are intended to meet the goals of the Stormwater Utility, the Natural Resources Division of the Public Works Department, and the City of Redmond Comprehensive Plan.

- **Redmond Shoreline Restoration Plan** – Indicates where and how voluntary improvements in water and upland areas can enhance the local shoreline environment. The plan supports the state's broader goal of protecting and restoring Shorelines of the State, inclusive of restoring Puget Sound.

5.3.1 Protection Watersheds

Protection watersheds are the most pristine, and have the least degraded streams in Redmond. In these watersheds, preservation of existing conditions is the priority, because few improvements are needed to support beneficial uses. The City's protection watersheds include Colin Creek, Mackey Creek, and Seidel Creek. These streams are used as regional references for optimal conditions in lowland King County streams.

The watersheds of these three creeks generally have high forestland coverage with intact stream buffers, and stream channels with complex structure. This is largely because the protection watersheds in Redmond are within two parks owned and operated by the City: Farrel McWhirter Park and the Redmond Watershed Preserve Park. Both parks are east of the city's contiguous limits, and east of the King County growth management boundary. As such, Redmond is committed to preserving these forested parks as highly functioning habitat and places where people can enjoy scenic trails through some of the oldest, intact forests within the City. Although these watersheds are pristine in comparison to other watersheds within the City, there are some impacts from human activities, and addressing these will further improve aquatic health in these streams.

Protection watersheds are illustrated in Figure 5.2. The following are specific actions needed to improve conditions within each creek and watershed.

5.3.1.1 Colin Creek

Colin Creek's headwater is a large wetland complex within the Redmond Watershed Preserve Park. The creek travels north from the park and joins Bear Creek outside the City in King

County. The portion of Colin Creek within the Redmond Watershed Preserve Park is approximately 7 percent of the total stream length, all of which is high quality aquatic habitat. The portion of the watershed of Colin Creek that is within the City is protected as a natural park and includes trails that allow people to interact with the natural environment.

Each stream function and the actions needed to restore that function are detailed below.

Hydrologic

No actions are recommended to improve the hydrology of Colin Creek.

Hydraulic

No actions are recommended to improve the hydraulics of Colin Creek.

Geomorphic

No actions are recommended to improve the geomorphic functions of Colin Creek.

Physiochemical

Colin Creek would benefit from the removal of invasive plants within the buffer. Invasive plants are in limited areas and would not be difficult to eradicate.

Biologic

Removal of an old railroad bridge that crosses Colin Creek would eradicate the one partial fish barrier located in Redmond.

5.3.1.2 Mackey Creek

Mackey Creek begins in the Redmond Watershed Preserve, flows east through Farrel McWhirter Park, and drains to Bear Creek in King County east of Redmond's contiguous city limits. Mackey Creek is more impacted by human activity than Colin and Seidel Creek. A portion of Farrel McWhirter Park is a hobby farm with a landscaped area for park patron use. The hobby farm is operated by the City and provides opportunities for children that include summer camps and classes in farm animal handling. The remainder of the park is forested with trails that cross the creek in multiple locations.

Each stream function, and the actions needed to restore that function, is detailed below.

Hydrologic

No actions are recommended to improve the hydrology of Mackey Creek.

Hydraulic

No actions are recommended to improve the hydraulics of Mackey Creek.

Geomorphic

Mackey Creek would benefit from improved instream complexity in the reach through Farrel McWhirter Park. Recommended actions include removing excessive sediment accumulated during construction and development of adjacent lands in King County. Redeveloping a channel on the west side of Farrel McWhirter Park would improve habitat conditions as the current braided channel is choked by reed canarygrass.

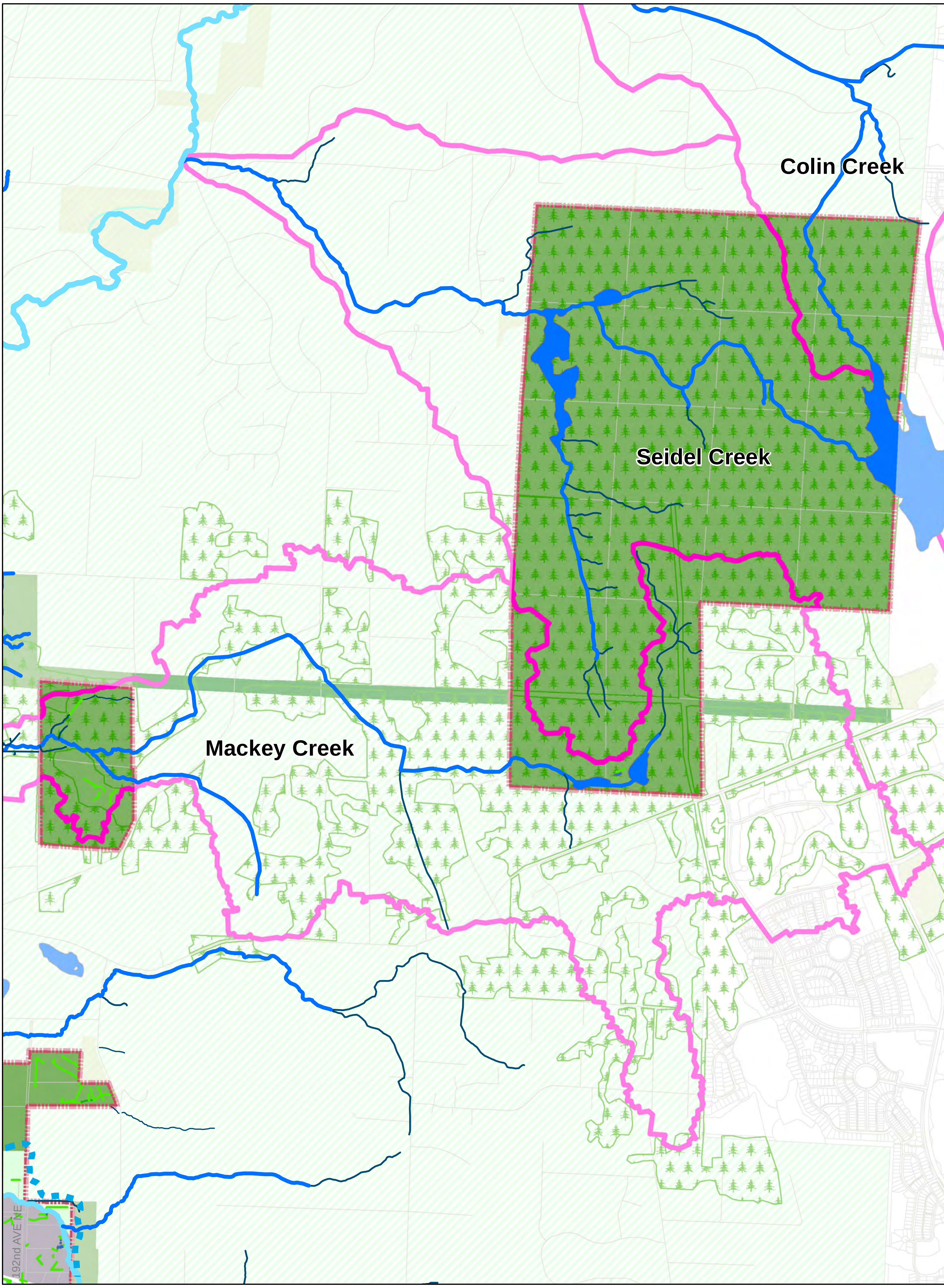


Figure 5.2 - Protection Watersheds and Future Land Use

City of Redmond, Washington
11/22/2013

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0 0.125 0.25 0.5 Miles

Disclaimer: This map is created and maintained by the Natural Resources Division of the City of Redmond, Washington, for reference purposes only. The City makes no guarantee as to the accuracy or completeness of the features shown on this map.

Legend

Class I Stream	Single-Family Constrained	Manufacturing Park
Class II Stream	Single-Family Urban	Design District
Class III Stream	Multi-Family Urban; Multi-Family Urban	Urban Recreation
Class IV Stream	Neighborhood Commercial	Semi-Rural
Watershed Boundary	General Commercial	Park and Open Space
City Limits	Downtown Mixed Use	Agriculture (outside of UGA)
Stormwater Infrastructure	Overlake Mixed Use	Rural (outside of UGA)
Forest	Business Park	Road

Physiochemical

Restoring and enhancing impacted buffers would significantly benefit Mackey Creek. Although most of the creek's buffers are fully intact, some areas need restoration and others have invasive species which should be removed.

Biologic

Redeveloping a channel in the west side of the park as part of the braided channel system that is currently overgrown with reed canarygrass or removing the reed canarygrass would remedy fish barriers on Mackey Creek that are under Redmond jurisdiction.

5.3.1.3 Seidel Creek

Seidel Creek was once used as a drinking water supply by the City of Redmond. Water was impounded by a concrete dam located within the Redmond Watershed Preserve Park. This use of the creek and associated watershed is why this area has been owned and operated by the City for almost a century. Although the use of Seidel Creek as a water supply was short lived, the dam still exists, creating an artificial water impoundment and a fish barrier. The Seidel Creek watershed extends both east and west of the Redmond Watershed Preservation Park; however the creek channel begins within the park and joins Bear Creek within King County, east of Redmond's contiguous city limits. Headwaters to Seidel Creek include smaller non fish bearing creeks and a large wetland complex that is also a headwater for Colin Creek.

Each stream function, and the actions needed to restore that function, are detailed below.

Hydrologic

No actions are recommended to improve the hydrology of Seidel Creek.

Hydraulic

No actions are recommended to improve the hydraulics of Seidel Creek.

Geomorphic

One segment of Seidel Creek would benefit from improved instream complexity.

Physiochemical

Seidel Creek would benefit from the removal of invasive plants within the buffer. Invasive plants are in limited areas and would not be difficult to eradicate.

Biologic

Remove the dam and other fish passage barriers to allow fish passage to Seidel Creek.

5.3.2 Highest Restoration Watersheds

5.3.2.1 Bear Creek

Bear Creek is one of WRIA 8's most promising salmon bearing creeks and located partially within the City's urban growth boundary (Figure 5.3). Outside the urban growth boundary, and outside the City of Redmond, this watershed is one of the healthiest, best protected, and valuable watersheds to aid the recovery of salmon. Bear Creek continues to have wild Chinook salmon runs in addition to most other salmonid species. This section of the plan focuses on the watershed area within Redmond that drains to the main stem of Bear Creek. In addition to areas draining to the main stem, within Redmond there are three Class II streams that also contribute to the greater Bear Creek Watershed: Perrigo Creek, Tyler's Creek, and Monticello Creek. Those creeks and watersheds are discussed in this chapter under 5.3.3.2, 5.3.3.4, and 5.3.2.4, respectively. The majority of the greater Bear Creek Watershed within Redmond drains to Class II creeks.

Bear Creek has a TMDL Study and Water Quality Implementation Plan (WQIP) (Ecology 2011b) to address documented water quality issues. Documented issues include high water temperature and low dissolved oxygen in summer, and fecal coliform in concentrations too high for designated uses. The WQIP includes specific actions the City of Redmond has committed to execute to address water quality issues. The TMDL focuses on main channel areas, although as stated in the previous paragraph multiple Class II creeks contribute to the main channel of Bear Creek within Redmond. While many of the activities required pursuant to WQIP have been complete, this WMP does relieve the City of any remaining commitments. Remaining commitments have been incorporated into this chapter for all watersheds within Redmond that contribute to Bear Creek.

Most of the Bear Creek watershed outside of Redmond is protected by the urban growth boundary and is one of the reasons King County has strong urban growth boundary regulations. Unfortunately, Bear Creek is impacted by development and human activities, especially within Redmond. This portion of the City has for decades been used for aggregate mining and industrial land uses. The following recommendations organized by stream function only address areas of the Bear Creek watershed located within Redmond that drain to the main stem. Table 5.2 summarizes rehabilitation tools recommended for this watershed.

Hydrologic

Hydrologic analysis performed by Ecology, at the WRIA 8 scale, indicates that the vast majority of the Bear Creek watershed (50 square miles) is intact hydrologically. Only the portion of the greater watershed located within the City of Redmond is characterized as impacted. It's important to note that hydrologic impacts upstream compound and greatly influence the hydrology in the lowest reaches. In addition, most developed areas of the Bear Creek watershed within Redmond do not have adequate flow control facilities. In response, Redmond has initiated regional flow control and runoff treatment retrofits in this area.

All other means to reduce the quantity of runoff entering Bear Creek are recommended (such as infiltration of roof runoff or use of rain gardens) as the soils are generally comprised of rapidly infiltrating outwash. Infiltrating runoff will reduce hydrologic impacts; however, Redmond utilizes the shallow unconfined aquifer beneath the Sammamish and Bear Creek valleys for a drinking water source. Therefore, care and attention to ensure groundwater is protected is a priority in areas located within Wellhead Protection Zone 1 and 2 (Figure 3.8). Infiltration will recharge the aquifer, which is important for its longevity.

Hydraulic

Improvements to address hydraulic conditions within Bear Creek totaling $10 million are under construction while this document is being created. Funding for this improvement

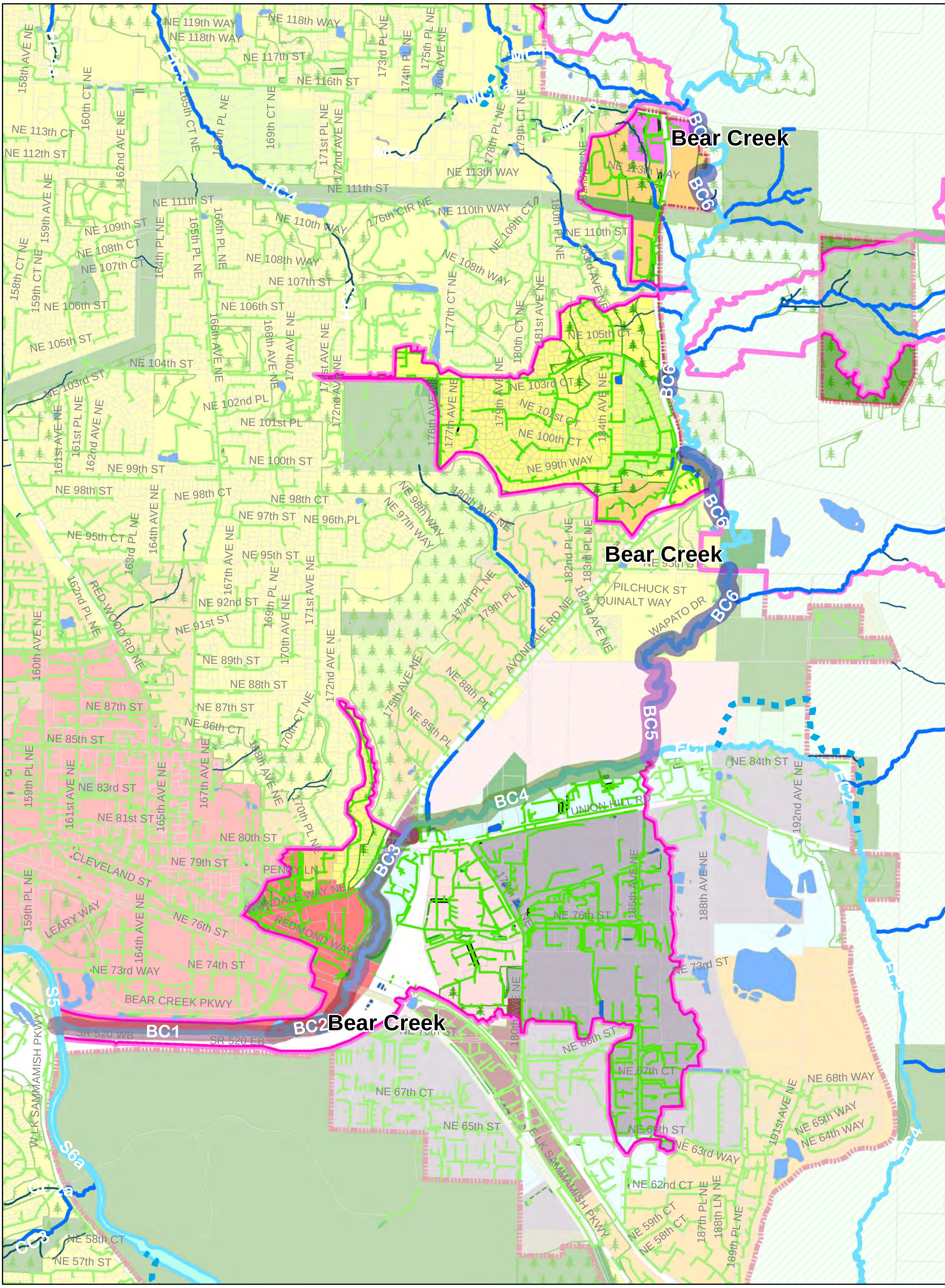

Figure 5.3 - Bear Creek Needs Assesment Reaches and Future Land Use

City of Redmond, Washington

11/22/2013

0 0.125 0.25 0.5 Miles

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City of Redmond WASHINGTON

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Legend

REACHID

- BC1
- BC2
- BC3
- BC4
- BC5
- BC6

- Class I Stream
- Class II Stream
- Class III Stream
- Class IV Stream
- Watershed Boundary
- City Limits
- Stormwater Infrastructure
- Forest

- Single-Family Constrained
- Single-Family Urban
- Multi-Family Urban; Multi-Family Urban
- Neighborhood Commercial
- General Commercial
- Downtown Mixed Use
- Overlake Mixed Use
- Business Park

- Manufacturing Park
- Design District
- Urban Recreation
- Semi-Rural
- Park and Open Space
- Agriculture (outside of UGA)
- Rural (outside of UGA)
- Road

Table 5.2. Bear Creek Watershed Rehabilitation Strategies.

Reach	Description of Current Conditions/Problems/Land Use	Future Land Use Designation	Highest Priority→ 1 – Hydrologic	2 – Hydraulic	3 – Geomorphic	4 – Physiochemical	5 – Biologic (Lowest Priority)
BC1	Relocate channel, ditched riprap channel, straightened channel, partially forested	Downtown Mixed Use	(2) Construct or retrofit stormwater infiltration facilities (5) Increase flow control facility inspection	(6) Add side channel (7) Relocate and/or reconnect creek, tributaries, riparian wetlands, floodplain	(10) Re-meander creek channel (11) Add instream complexity (12) Supplement instream gravel (13) Stabilize banks (14) Add grade control	(15) Perform pollution source control inspections (16) Clean Streets (19) Track pollution sources (20) Restore buffers (22) Increase runoff treatment facility inspections	
BC2	Restored by WSDOT (re-meander channel complexity & buffer) in 1999. Bridge pilings in channel (creosote)	Design District Manufacturing Park Single Family Urban					(24) Remove fish barrier(s)
BC3	Industrial and commercial area of city, heavily developed, channel restricted under Redmond Way – Union Hill	Manufacturing Park Business Park Design District	(1) Construct or retrofit stormwater flow control facilities (2) Construct or retrofit stormwater infiltration facilities (5) Increase flow control facility inspection		(11) Stabilize banks	(15) Perform Pollutant Source Control Inspections (16) Clean Streets (17) Construct or Retrofit Stormwater Runoff Treatment Facilities (19) Track pollution sources (20) Restore buffers (22) increased runoff treatment facility inspections	(24) Remove fish barrier
BC4	Ditched and diked farm that used to be a wetland, mostly farmland north, commercial south, some partially restored buffers to the south	Design District Business Park Manufacturing Park	(5) Increase flow control facility inspection	((7) Relocate and/or reconnect creek, tributaries, riparian wetlands, floodplain	(11) Add instream complexity	(15) Perform Pollutant Source Control Inspections (16) Clean Streets (17) Construct or Retrofit Stormwater Runoff Treatment Facilities (19) Track pollution sources (20) Restore buffers (22) increased runoff treatment facility inspections (23) Ecology Permitted Site Support	
BC5	Ditched and diked farm that used to be a wetland, mostly farmland north, some partially restored buffers to the south	Single Family Urban Neighborhood Commercial		(7) Relocate and/or reconnect creek, tributaries, riparian wetlands, floodplain	(11) Add instream complexity	(20) Restore buffers	
BC6	Single & multifamily	Single Family Urban	(1) Construct or retrofit stormwater flow control facilities (2) Construct or retrofit stormwater infiltration facilities (4) Increase forested areas in the watershed		(10) Re-meander Creek Channel	(15) Perform pollutant source control inspections (16) Clean streets (17) Construct or retrofit stormwater runoff treatment facilities (18) Provide education & outreach (19) Track pollution sources (22) Increase runoff treatment facility inspections	(23) Remove fish barrier

has been provided by Washington Department of Transportation to mitigate impacts from SR 520 construction. Reaches BC1, BC3, and BC4 are being relocated and designed to address hydraulic impacts caused by existing watershed conditions. The current channel location in reach BC1 is too close to SR 520 and is disconnected from intact wetlands in reaches BC3 and BC4. The new channel is designed to connect with off-channel habitat during high flows.

Geomorphic

As with hydrologic and hydraulic functions, geomorphic functions would also benefit from moving and rebuilding the channel. The rebuilt channel will include elements critical to geomorphic function such as woody debris, pools, and instream complexity.

Physiochemical

Most of the development in the watershed is lacking stormwater runoff treatment facilities. In addition to retrofitting stormwater runoff treatment facilities, pollution source control inspections of businesses could greatly reduce pollution entering runoff. To address high fecal coliform counts in Bear Creek, it is recommended that commercial land uses that have the potential to generate fecal coliform polluted runoff be identified and inspected to identify source sites. Then the City can work with the owners to identify ways to reduce fecal coliform in Bear Creek. Replanting buffers with shade producing trees would help lower summer water temperatures.

Reach BC4 would benefit from Ecology permit site support where the City would work with state permitted stormwater facilities to annually review their SWPPP and pollution prevention measures, to provide technical support, and potentially fund solutions to existing water quality issues.

Biologic

There are no fish barriers in main stem Bear Creek.

5.3.2.2 Clise Creek

Clise Creek is Redmond's smallest watershed and drains to the left bank of the Sammamish River (Figure 5.4). This watershed is unique in that large portions of the watershed, mainly where the creek channel is located, are intact forest. The developed areas consist of residential development and roads. The upper reaches of the creek have not been impacted by stormwater discharges because stormwater is piped to the lower reaches. With this configuration, the watershed is well suited for retrofitting the stormwater system that manages runoff from existing development. Although a smaller Class II system, a restored Clise Creek would provide habitat and refuge for salmonids during warm weather and high-flow storm events. Table 5.3 summarizes rehabilitation tools recommended for this watershed.

Hydrologic

All development in the watershed drains to one reach (CC2A) of Clise Creek. Retrofitting this area with stormwater infiltration facilities and flow control facilities would greatly reduce hydrologic impacts from the existing development.

Hydraulic

No hydraulic issues or needed actions to remedy hydraulic issues are identified in this watershed.

Geomorphic

Clise Creek would benefit from projects to address a lack of instream complexity. Reach CC1 is the most degraded and would benefit from remeandering the creek channel once hydrologic impacts are addressed upstream.

Physiochemical

Most of the development in the watershed is lacking stormwater runoff treatment facilities. Although most of the channel has quality buffer habitat, reach CC1 needs full buffer restoration, and the remaining buffers could use enhancement to maximize the functionality of the buffer. Street sweeping this watershed would be a beneficial exercise to reduce pollutant loading to the creek. Last, education and outreach efforts to the homeowners in this watershed would help reduce pollution entering the system and promote invasive species removal.

Biologic

There is a fish barrier at the east side of Westlake Sammamish Parkway that should be removed.

5.3.2.3 Evans Creek

Figure 5.5 illustrates future land use in the Evans Creek watershed, shows the recommended route for relocating Evans Creek, and illustrates the reaches of the creek under the City's jurisdiction. The recommended set of watershed rehabilitation tools for each reach is provided in Table 5.4.

Restoring the portions of Evans Creek that are within Redmond poses significant challenges. The creek is the most critical for salmon recovery among all the City's Class I waters, and is specifically identified as one of the most important creeks for salmon recovery in WRIA 8.

Evans Creek has a TMDL Study and WQIP (Ecology 2011b) to address documented water quality issues. Documented issues include high water temperature and low dissolved oxygen in summer, and fecal coliform in concentrations too high for designated uses. The WQIP includes specific actions the City of Redmond has committed to execute to address water quality issues. While many of the activities required pursuant to WQIP have been complete, this WMP does relieve the City of any remaining commitments. These remaining commitments have been incorporated into Table 5.4. Recommended watershed and stream rehabilitation tools for improving this watershed are listed below in their respective stream functions pyramid categories.

Hydrologic

The area of Evans Creek watershed within Redmond (504 acres) is the lowest downstream portion of a large watershed (9,800 acres). Hydrologic impacts within the Redmond portion of Evans Creek watershed are driven by upstream conditions outside of the City. Existing

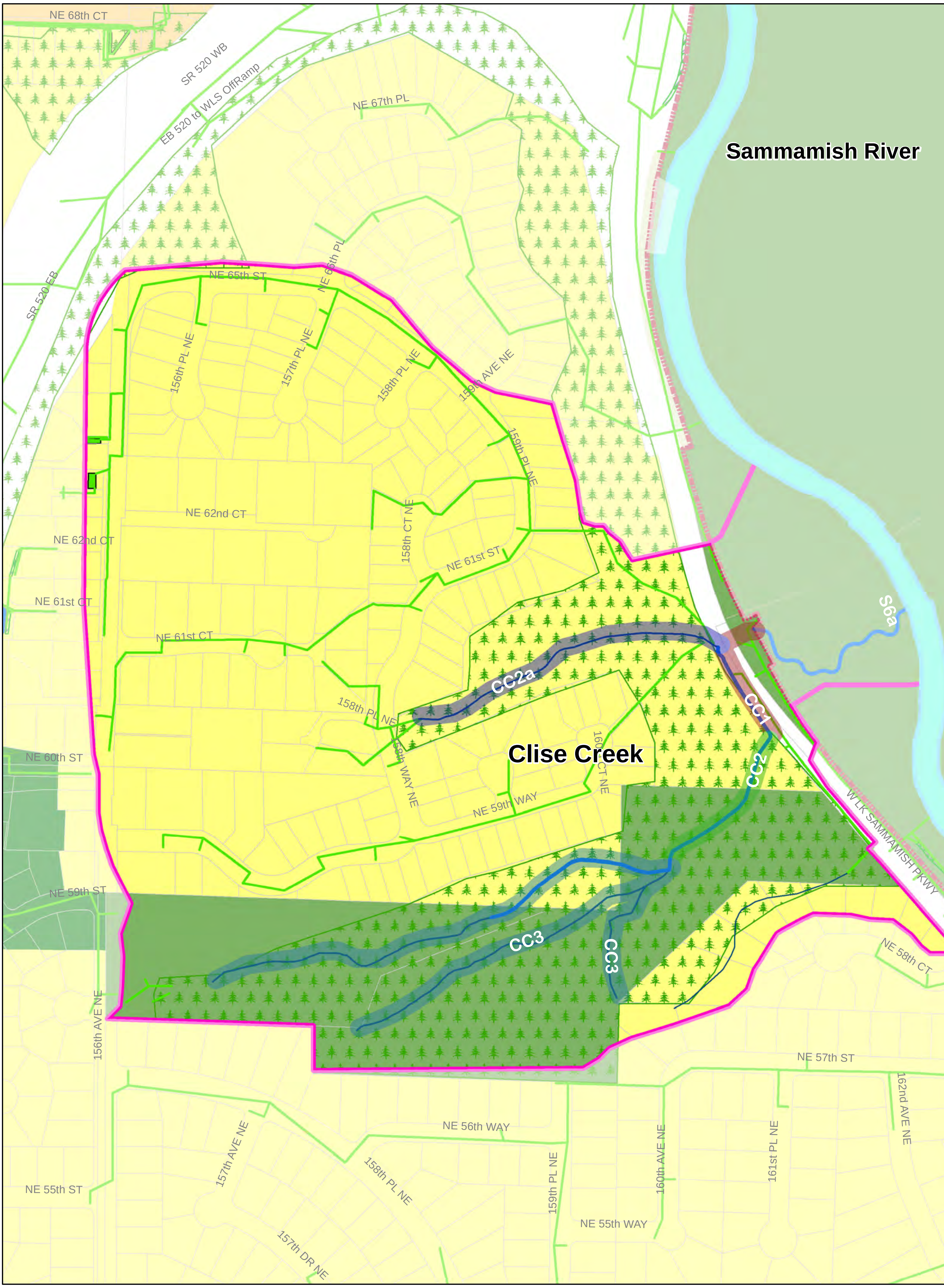

Figure 5.4 - Clise Creek Needs Assesment Reaches and Future Land Use

City of Redmond, Washington

11/22/2013

City of Redmond WASHINGTON

N

0 125 250 500 Feet

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Legend

REACHID

- CC1
- CC2
- CC2a
- CC3

- Class I Stream
- Class II Stream
- Class III Stream
- Class IV Stream
- Watershed Boundary
- City Limits
- Stormwater Infrastructure
- Forest

- Single-Family Constrained
- Single-Family Urban
- Multi-Family Urban; Multi-Family Urban
- Neighborhood Commercial
- General Commercial
- Downtown Mixed Use
- Overlake Mixed Use
- Business Park

- Manufacturing Park
- Design District
- Urban Recreation
- Semi-Rural
- Park and Open Space
- Agriculture (outside of UGA)
- Rural (outside of UGA)
- Road

Table 5.3. Clise Creek Watershed Rehabilitation Strategies.

Reach	Description of Current Conditions/ Problems/Land Use	Future Land Use Designation	Highest Priority--------→--------→-------→--------→--------Lowest Priority 1 – Hydrologic	2 – Hydraulic	3 – Geomorphic	4 – Physio-chemical	5 – Biologic
CC1	Rock lined roadside ditch, sidewalk serves as wall, limited riparian, (Hydrology not flashy, very little stormwater input, old growth). Relocate creek.	Single Family Urban	(2) Construct or retrofit stormwater infiltration facilities		10) Re-meander creek channel (11) Add instream complexity	(20) Restore buffers	(23) Remove fish barrier
CC2	No stormwater input, forested/established channel is slightly incised, limited instream wood, flood plain is connected.	Single Family Urban			(11) Add instream complexity	(21) Enhance buffers	
CC2A	Flashy from stormwater inputs, relatively steep sloped/confined stream channel.	Single Family Urban	(1) Construct or retrofit stormwater flow control facilities (2) Construct or retrofit stormwater infiltration facilities		(11) Add instream complexity	(1) Construct or retrofit stormwater flow control facilities (18) Provide education & outreach (21) Enhance buffers	
CC3	No stormwater input, forested/established channel is slightly incised, limited instream wood, flood plain is connected.	Single Family Urban			(11) Add instream complexity	(21) Enhance buffers	

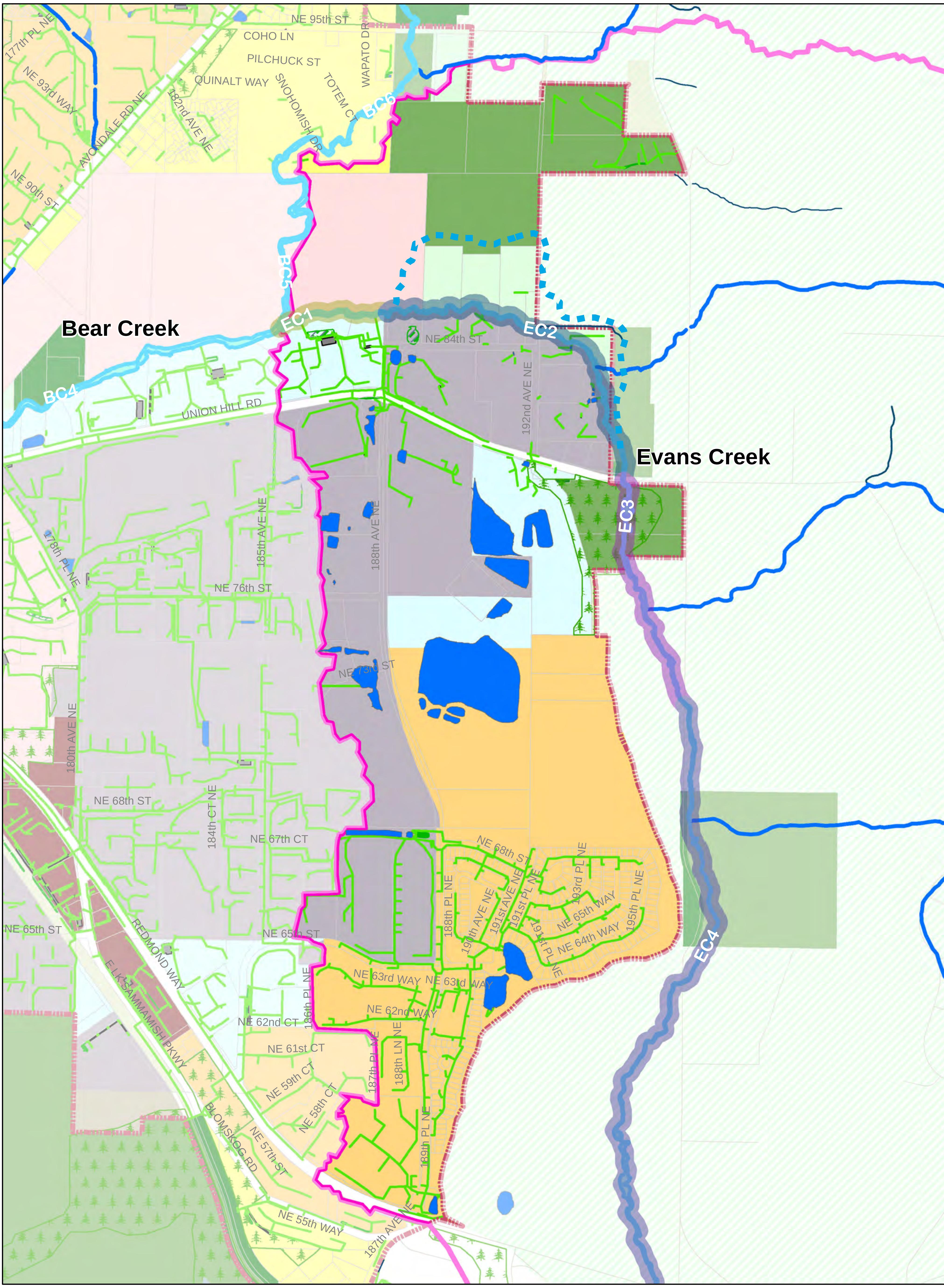

Figure 5.5 - Evans Creek Needs Assesment Reaches and Future Land Use

City of Redmond, Washington

11/22/2013

Legend

REACHID

- EC1
- EC2
- EC3
- EC4

- Watershed Boundary
- City Limits
- Stormwater Pipe
- Forest
- Class I Stream
- Class II Stream
- Class III Stream
- Class IV Stream
- Single-Family Constrained
- Single-Family Urban
- Multi-Family Urban; Multi-Family Urban
- Neighborhood Commercial
- General Commercial
- Downtown Mixed Use
- Overlake Mixed Use
- Business Park
- Manufacturing Park
- Design District
- Urban Recreation
- Semi-Rural
- Park and Open Space
- Agriculture (outside of UGA)
- Rural (outside of UGA)
- Road

Table 5.4. Evans Creek Watershed Rehabilitation Strategies.

Reach	Description of Current Conditions/Problems/Land Use	Future Land Use	Highest Priority→ 1 – Hydrologic	→ 2 – Hydraulic	→ 3 – Geomorphic	→ 4 – Physiochemical	Lowest Priority 5 – Biologic
EC1	Historically channelized, low gradient, adjacent ditched farmland, narrow buffers, one partial fish barrier	Design district and business park	(1) Construct or retrofit stormwater flow control facilities (2) Construct or retrofit stormwater infiltration facilities (5) Increase flow control facility inspections (4) Protect and increase forested areas in the watershed	(7) Relocate and/or reconnect creek, tributaries, riparian wetlands, floodplain	(10) Re-meander creek channel (11) Add instream complexity	(15) Perform pollutant source control inspections (16) Clean streets (17) Construct or retrofit stormwater runoff treatment facilities (20) Restore buffers (22) Increase runoff treatment facility inspections (23) Ecology Permitted Site Support	(24) Remove fish barrier(s)
EC2	Water quality may be impacted from adjacent industrial area, very limited to nonexistent buffers, limited runoff treatment and flow control, five partial fish barriers	Manufacturing park	(1) Construct or retrofit stormwater flow control facilities (2) Construct or retrofit stormwater infiltration facilities (5) Increase flow control facility inspections	(7) Relocate and/or reconnect creek, tributaries, riparian wetlands, floodplain	(10) Re-meander creek channel (11) Add instream complexity	(15) Perform source control inspections (16) Clean streets (17) Construct or retrofit stormwater runoff treatment facilities (21) Enhance buffers (22) Increase runoff treatment facility inspections	(24) Remove fish barrier(s)
EC3	Forested intact buffer, one partial fish barrier	Park and open space	(4) Protect and increase forested areas in the watershed			(21) Enhance buffers	(24) Remove fish barrier(s)
EC4	Channel and associated wetlands are outside city limits	Land use in watershed within City is multi-family urban and manufacturing park	(1) Construct or retrofit stormwater flow control facilities (2) Construct or retrofit stormwater infiltration facilities (5) Increase flow control facility inspections			(15) Perform source control inspections (16) Clean streets (17) Construct or retrofit stormwater runoff treatment facilities (18) Provide education and outreach (23) Ecology Permitted Site Support	

development within the City that drains to Evans Creek does not comply with current standards for stormwater flow control. It is important to require new development and redevelopment in this watershed to provide adequate flow control; however, transferring flow control retrofits to this watershed is not a high priority.

All other means to reduce the quantity of runoff entering Evans Creek are recommended (such as infiltration of roof runoff or use of rain gardens) as the soils are generally comprised of rapidly infiltrating outwash. Infiltrating runoff will reduce hydrologic impacts; however, Redmond utilizes the shallow unconfined aquifer beneath the Sammamish and Bear Creek valleys for a drinking water source. Therefore, care and attention to ensure groundwater is protected is a priority in areas located within Wellhead Protection Zone 1 and 2 (Figure 3.8). Infiltration will recharge the aquifer, which is important for its longevity.

Inspect and require maintenance and cleaning of private flow control facilities not designed to current standards. Increase inspection frequency of both public and private facilities if facility frequently requires cleaning during the routine inspections required by the City's NPDES permit.

Hydraulic

To support the recovery of Evans Creek, the creek channel should be moved from its current location, which bisects industrialized parcels in Redmond, to areas where buffers can be provided. In its current location, redevelopment is constrained due to the existing buffer requirements. An alternative to relocating the creek would be to restore the channel and buffer in its current location within the industrialized parcels; this alternative would essentially eliminate businesses or limit their use of current locations, which may have adverse effects on business owners. Steps are being taken to acquire property rights north and east of the current channel, and conceptual design plans have been prepared for channel relocation. The relocated channel will provide greater habitat complexity for salmon as well as other aquatic species, and will be designed to accommodate the flows entering the creek from outside the City. Once moved, existing wetlands and floodplain will be connected to the channel and a forested buffer will be planted to provide high quality riparian habitat.

Geomorphic

Recreate a meandering creek channel in reaches EC1 and EC2 to create additional in-channel habitat with a dynamically stable channel form.

Add pools, large woody debris, and other features to reaches EC1 and EC2 to improve instream complexity.

Physicochemical

Source control inspections, as required by Ecology (Ecology 2005), of industrial and commercial properties in the watershed will be used to reduce pollution entering Evans Creek and the shallow unconfined drinking water aquifer beneath the watershed.

Increase frequency of street sweeping efforts in reaches EC1, EC2, and EC4 to reduce pollution from high use roads and roads adjacent to industrial and commercial land uses.

This watershed has a high redevelopment potential by 2030, which will result in more runoff entering the creek. As redevelopment occurs, improved runoff treatment will be important to benefit water quality. Retrofitting existing development will also help reduce water quality impacts from stormwater runoff. Likewise, retrofitting industrial areas and busy roads, with runoff treatment facilities will provide a cost effective way to achieve significant reductions in stormwater pollution. Due to the proximity of drinking water wells, infiltration of runoff from pollution generating surfaces is not encouraged, except in residential areas. Transferring water quality treatment areas to this watershed in accordance with Chapter 4.2.3 of this plan is recommended.

Where the Evans Creek watershed is occupied by residential land uses, public education and outreach to encourage landowner stewardship will be used to increase awareness of how residents can protect and improve water quality.

In reaches EC1 and EC3, protect remaining intact forested areas and trees to retain shade for the creek as well as food sources for aquatic species.

For portions of the creek that are not being moved, restoring a buffer with a tree canopy to shade the creek will be necessary to improve water quality. A forested buffer will improve chronic low dissolved oxygen and high temperature conditions during summer months.

All reaches of Evans Creek are in need of buffer enhancement to control invasive plant species in addition to improving the water quality issues documented in the TMDL.

In reaches EC1 and EC2, increase inspection frequency of both public and private facilities if facility frequently requires cleaning during routine NPDES permit required inspections.

Reaches EC1 and EC4 would benefit from Ecology permit site support where the City would work with the state permitted stormwater facilities to annually review their SWPPP and pollution prevention measures, to provide technical support, and potentially fund solutions to existing water quality issues.

Biologic

Fish barriers are located in reaches EC1, EC2, and EC3. Relocating the creek channel will remove one fish barrier; remaining fish barriers should be removed to allow better access for salmon migration.

5.3.2.4 High School Creek

High School Creek poses some of the greatest challenges compared to other highest restoration creeks. High School Creek has multiple channels with older uncontrolled development contributing runoff to the upper reaches. The upper watershed is mostly developed with low density residential, some of which is under development pressure in the near future. High School Creek also has intact wetlands and forested buffers that make this watershed have a higher potential for restoration. Many of the stream functions are impacted by the existing conditions but with intentional improvements this watershed has a high potential to support a healthy ecosystem. Figure 5.6 shows future land use in the High School Creek watershed and illustrates the location of the creek reaches referred to in this discussion.

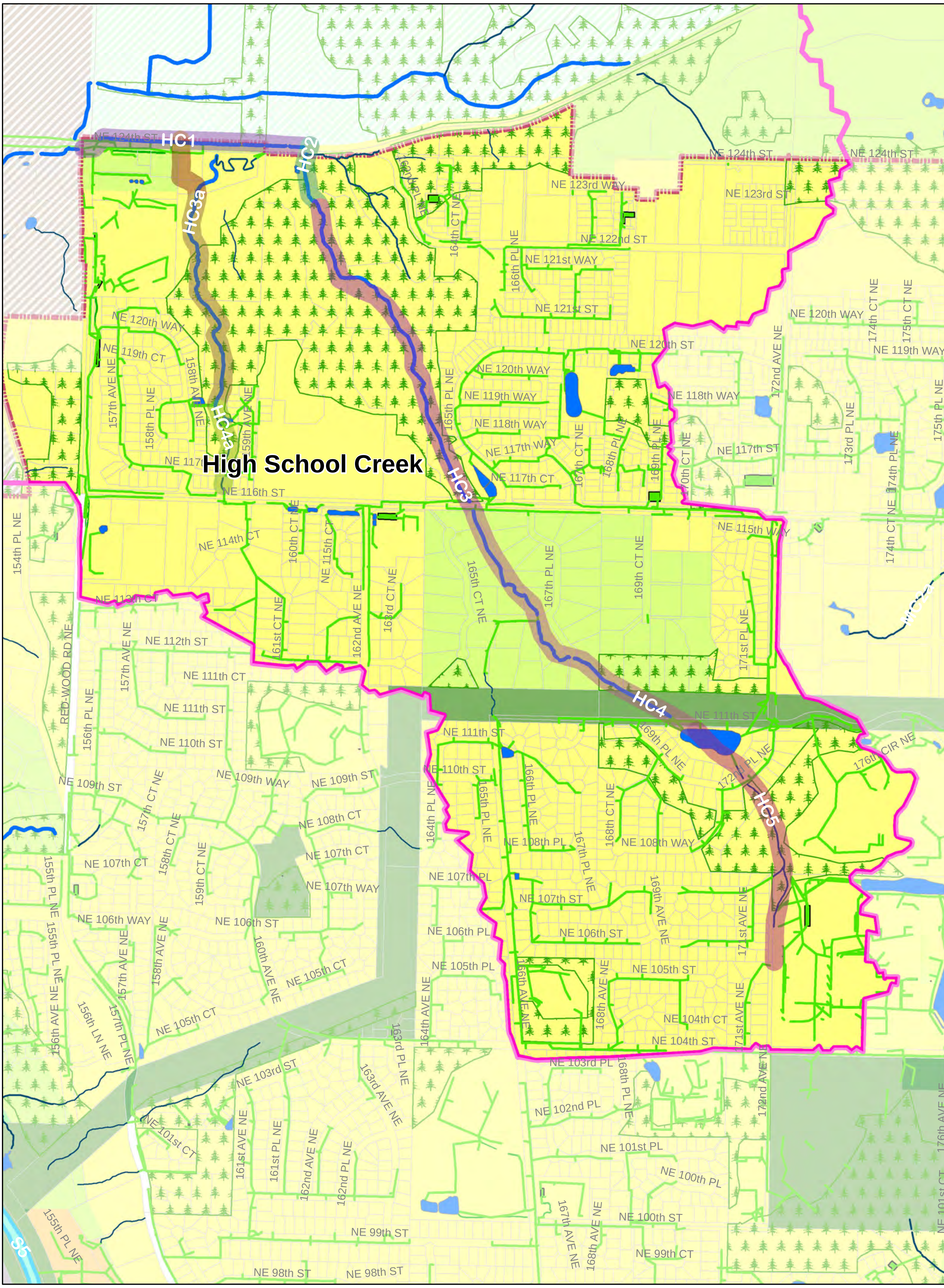

Figure 5.6 - High School Creek Needs Assesment Reaches and Future Land Use

City of Redmond, Washington
11/22/2013

0 0.05 0.1 0.2 Miles

N

City of Redmond WASHINGTON

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Legend

REACHID

- HC1
- HC2
- HC2a
- HC3
- HC3a
- HC4
- HC4a
- HC5

- Class I Stream
- Class II Stream
- Class III Stream
- Class IV Stream
- Watershed Boundary
- City Limits
- Stormwater Infrastructure
- Forest

- Single-Family Constrained
- Single-Family Urban
- Multi-Family Urban; Multi-Family Urban
- Neighborhood Commercial
- General Commercial
- Downtown Mixed Use
- Overlake Mixed Use
- Business Park

- Manufacturing Park
- Design District
- Urban Recreation
- Semi-Rural
- Park and Open Space
- Agriculture (outside of UGA)
- Rural (outside of UGA)
- Road

Recommended watershed and stream rehabilitation tools for improving this watershed are listed below in their respective stream functions pyramid categories and are summarized in Table 5.5.

Hydrologic

The restoration of High School Creek depends greatly on restoring a more natural hydrology. This includes retrofitting existing development with flow control facilities, infiltrating runoff as much a feasible, and looking for ways to preserve natural vegetation. Working with existing homeowner associations and Emerald Height Retirement Community to site and retrofit developed areas with flow control facilities will be important.

Some existing stormwater facilities should be considered for retrofitting to maximize their hydrologic benefit.

Hydraulic

As this plan is drafted, a new channel and buffer complex was constructed to address hydraulic issues in reach HC2. However, reach HC1 is located directly adjacent to NE 124th Street with little buffer between the roadbed and the creek itself. Moving this portion of the creek out of the right-of-way and into private property outside of Redmond is recommended; however, making this recommendation a reality will be very challenging. The property outside city limits is owned by Molbaks and in King County jurisdiction. Moving the creek would address the only hydraulic issue within the entire watershed, and would help with various other stream functions in reach HC2.

Geomorphic

Many reaches within High School Creek are in need of improvements to address geomorphic deterioration. Many reaches are rip rapped, incised, and not complex. Regrading the banks and adding instream complexity would address geomorphic issues in most reaches.

Physiochemical

Restoring buffers in the lower reaches would greatly improve the physiochemical function of the lower reaches. Retrofitting existing development with runoff treatment facilities, and educating homeowners on how they can reduce pollution in runoff from their residences, is needed in almost all reaches.

Biologic

Of all the highest restoration creeks, High School has the most fish barriers. Many of the fish barriers need to be removed to make this creek accessible to salmonids.

5.3.2.5 Monticello Creek

Figure 5.7 illustrates future land use in the Monticello Creek watershed, shows the recommended route for relocating a portion of a tributary, and illustrates the individual reaches of the creek within Redmond. The recommended set of watershed rehabilitation tools for each reach is provided in Table 5.6.

The Monticello Creek Watershed is one of the most rapidly developing residential areas in the City. The watershed has been transforming over the past decade from rural and low density residential to medium (1/4-acre lots) and higher density residential. Most developments have constructed a stormwater pond or vault that provides both runoff treatment as well as flow control. Unfortunately, a significant amount of research has shown that many existing stormwater facilities were designed to standards that will not fully protect creeks from hydrologic impacts (Booth et al. 2002).

Monticello Creek discharges to the main stem of Bear Creek just outside the city limits. As stated previously, Bear Creek is recognized regionally, and is highlighted for salmon recovery in WRIA 8. Monticello Creek is considered a part of Bear Creek from a state and federal perspective. Restoring the Monticello Creek watershed, which is largely inside city limits, is one of Redmond's best opportunities to support salmon recovery and to improve water quality issues in Bear Creek.

Recommended watershed and stream rehabilitation tools for improving this watershed are listed below in their respective stream functions pyramid categories.

Hydrologic

Monticello Creek Watershed has more existing development contracts than any other priority watershed in the City. If all the existing development agreements vested to older standards are developed under those old standards, Monticello Creek will be severely impacted. For existing developments with flow control facilities that do not meet current standards, the City will look for opportunities to retrofit the facilities. As additional areas within the Monticello watershed develop, the City should work with developers to construct new facilities to current standards, and provide site designs that lessen the impact.

There are also developed areas of the watershed with severely inadequate flow control, for example, the 116th Avenue NE area. There are various feasible options to provide flow control in such areas, which the City will explore.

In addition to adding and retrofitting flow control facilities, the City will encourage future development to infiltrate roof runoff and use green stormwater infrastructure options when feasible based on-site conditions.

Future developments should be designed to minimize stormwater runoff quantity (such as with roof infiltration) but should also minimize impervious surfaces to the extent possible. The Monticello watershed is currently 23 percent impervious. This watershed will easily exceed 30 percent impervious if all approved development is constructed.

In addition to designing development with minimized impervious surfaces, this watershed will benefit greatly from preservation of forested areas. This can be accomplished by acquiring land or easements for permanent protection as well as by designing developments in clustered formations with set aside forested tracts.

For all reaches of Monticello Creek, inspect, and require maintenance and cleaning of private flow control facilities not designed to current standards, and increase inspection frequency of both public and private facilities if facility frequently requires cleaning during the routine inspections prescribed by the City's NPDES permit.

Table 5.5. High School Creek Watershed Rehabilitation Strategies.							
			Highest Priority---→---→---→---→---Lowest Priority				
Reach	Description of Current Conditions/Problems/ Land Use	Future Land Use Designation	1 – Hydrologic	2 – Hydraulic	3 – Geomorphic	4 – Physiochemical	5 – Biologic
HC1	Roadside ditched, riprap channel, wood weirs, densely lined with willows on banks.	Single Family Urban		(7) Relocate and/or reconnect creek, tributaries, riparian wetlands, floodplain	(10) Re-meander creek channel (11) Add instream complexity	(20) Restore buffers	(23) Remove fish barrier
HC2	Culvert undersized under 124th, several fish barriers, ditched armored with ecology blocks & garbage, manmade ponds hydrologically connected, invasive weeds and abandoned building in buffer.	Single Family Urban			(9) Re-grade banks (11) Add instream complexity (12) Supplement instream gravel (14) Add grade control	(20) Restore buffers	(23) Remove fish barrier
HC3	Second growth forest, flashy flows, newer dense development with some flow control	Single Family Urban	(1) Construct or retrofit stormwater flow control facilities (2) Construct or retrofit stormwater infiltration facilities (3) Change Zoning Code (4) Protect and increase forested areas in the watershed (5) Increase flow control facility inspection		(11) Add instream complexity	(17) Construct or Retrofit Stormwater Runoff Treatment Facilities	
HC3A	Lowest portion of reach was relocated with buffer and instream channel restoration, incised by storm flows, existing riparian wetlands, partially forested, ample opportunity	Single Family Urban	(1) Construct or retrofit stormwater flow control facilities (2) Construct or retrofit stormwater infiltration facilities (4) Protect and increase forested areas in the watershed (5) Increase flow control facility inspection		(11) Add instream complexity (12) Supplement instream gravel l (13) Stabilize banks (14) Add grade control	(17) Construct or Retrofit Stormwater Runoff Treatment Facilities (18) Provide education & outreach programs (20) Restore buffers	
HC4	Larger residential lots, some established groves, many yards extend to channel edge, riprap channel in areas, some partial barriers, braids out under power lines.	Single Family Urban Single Family Constrained	(1) Construct or retrofit stormwater flow control facilities (2) Construct or retrofit stormwater infiltration facilities		(11) Add instream complexity (12) Supplement instream gravel	(18) Provide education & outreach programs (20) Restore buffers	(24) Remove fish barrier(s)
HC4A	Channel riprap in sections, not incised due to riprap, portions in riparian wetland, scattered groves.	Single Family Urban (4) Protect and increase forested areas in the watershed	(1) Construct or retrofit stormwater flow control facilities (2) Construct or retrofit stormwater infiltration facilities (3) Change zoning code		(11) Add instream complexity (12) Supplement instream gravel	(18) Provide education & outreach programs (21) Enhance buffers	
HC5	Mostly Emerald Heights Retirement development, Abbey Pond instream, portion forested, piped section, gabion baskets, sand beds.	Single Family Urban Single Family Constrained	(1) Construct or retrofit stormwater flow control facilities (2) Construct or retrofit stormwater infiltration facilities		(11) Add instream complexity (12) Supplement instream gravel l (13) Stabilize banks (14) Add grade control	(21) Enhance buffers	

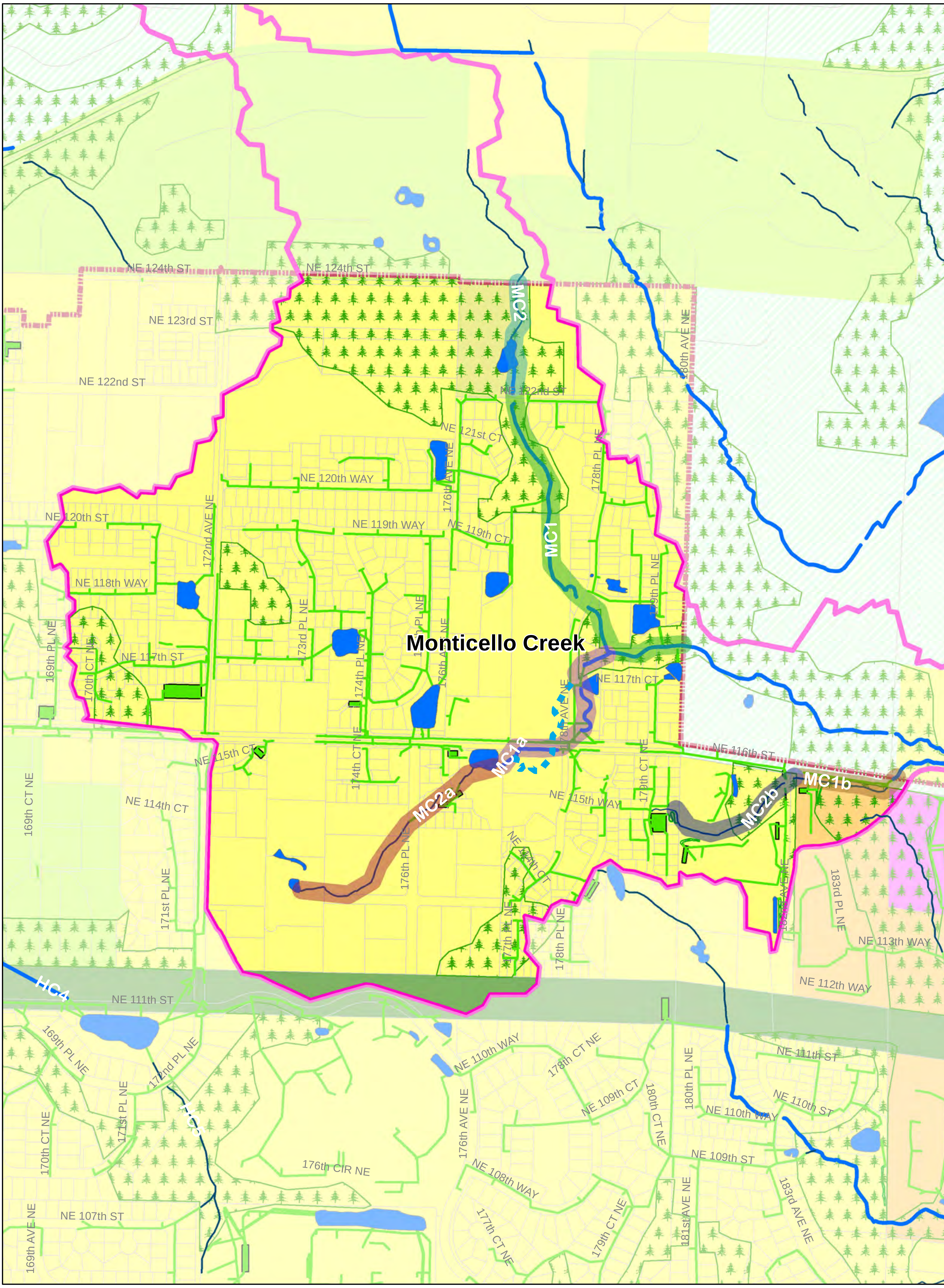

Figure 5.7 - Monticello Creek Needs Assesment Reaches and Future Land Use

City of Redmond, Washington

11/22/2013

N

0 0.05 0.1 0.2 Miles

City of Redmond WASHINGTON

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Legend

REACHID

- MC1
- MC1a
- MC1b
- MC2
- MC2a
- MC2b

- Class I Stream
- Class II Stream
- Class III Stream
- Class IV Stream
- Watershed Boundary
- City Limits
- Stormwater Infrastructure
- Forest

- Single-Family Constrained
- Single-Family Urban
- Multi-Family Urban; Multi-Family Urban
- Neighborhood Commercial
- General Commercial
- Downtown Mixed Use
- Overlake Mixed Use
- Business Park

- Manufacturing Park
- Design District
- Urban Recreation
- Semi-Rural
- Park and Open Space
- Agriculture (outside of UGA)
- Rural (outside of UGA)
- Road

Table 5.6. Monticello Creek Watershed Rehabilitation Strategies.

Reach	Description of Current Conditions/Problems/ Land Use	Future Land Use	Highest Priority→ 1 – Hydrologic	→ 2 – Hydraulic	→ 3 – Geomorphic	→ 4 – Physiochemical	Lowest Priority 5 – Biologic
MC1	Located at transition of constrained valley reach and flat valley confluence with Bear Creek, no significant erosion issues, mostly adequate runoff treatment, inadequate flow control	Single family urban	(1) Construct or retrofit stormwater flow control facilities (2) Construct or retrofit stormwater infiltration facilities (4) Protect and increase forested areas in the watershed (5) Increase flow control facility inspections	(6) Add side channels	(11) Add instream complexity	(15) Perform pollutant source control inspections (16) Clean streets (17) Construct or retrofit stormwater runoff treatment facilities (18) Provide education and outreach (19) Track pollution sources (20) Restore buffers (21) Enhance buffers (22) Increase runoff treatment facility inspections	
MC2	Impoundment located on channel, adjacent riparian is vegetated to the west, open to east, one full fish barrier at impoundment	Single family urban	(2) Construct or retrofit stormwater infiltration facilities (4) Protect and increase forested areas in the watershed (5) Increase flow control facility inspections	(6) Add side channels	(11) Add instream complexity (13) Stabilize banks	(15) Perform pollutant source control inspections (16) Clean streets (17) Construct or retrofit stormwater runoff treatment facilities (18) Provide education and outreach (20) Restore buffers (22) Increase runoff treatment facility inspections	(24) Remove fish barriers
MC1a	Channelized reach (half in roadside ditch), buffers are open for majority of reach, several full fish barriers	Single family urban	(1) Construct or retrofit stormwater flow control facilities (2) Construct or retrofit stormwater infiltration facilities (5) Increase flow control facility inspections	(6) Add side channels (7) Relocate and/or reconnect creek, tributaries, riparian wetlands, floodplain	(10) Re-meander creek channel (11) Add instream complexity	(15) Perform pollutant source control inspections (16) Clean streets (17) Construct or retrofit stormwater runoff treatment facilities (18) Provide education and outreach (20) Restore buffers (22) Increase runoff treatment facility inspections	(24) Remove fish barriers
MC1b	Steep armored channel, runs in roadside ditch, one full and one partial fish barrier	Multifamily Urban	(1) Construct or retrofit stormwater flow control facilities (2) Construct or retrofit stormwater infiltration facilities (5) Increase flow control facility inspections		(10) Re-meander creek channel (11) Add instream complexity (14) Add grade control	(15) Perform pollutant source control inspections (16) Clean streets (17) Construct or retrofit stormwater runoff treatment facilities (18) Provide education and outreach (20) Restore buffers (22) Increase runoff treatment facility inspections	(24) Remove fish barriers

Table 5.6 (continued). Monticello Creek Watershed Rehabilitation Strategies.							
Reach	Description of Current Conditions/Problems/Land Use	Future Land Use	Highest Priority→ 1 – Hydrologic	→ 2 – Hydraulic	→ 3 – Geomorphic	→ 4 – Physiochemical	Lowest Priority 5 – Biologic
MC2a	Flat headwater reach, adjacent land use is partially forested and partially low-density residential development	Single family urban	(1) Construct or retrofit stormwater flow control facilities (2) Construct or retrofit stormwater infiltration facilities (4) Protect and increase forested areas in the watershed (5) Increase flow control facility inspections	(6) Add side channels	(11) Add instream complexity	(15) Perform pollutant source control inspections (16) Clean streets (17) Construct or retrofit stormwater runoff treatment facilities (18) Provide education and outreach (20) Restore buffers (22) Increase runoff treatment facility inspections	
MC2b	Flat headwater channel, broad buffer in areas, other areas have institutional development up to the channel edge, seasonal flow	Single family urban	(1) Construct or retrofit stormwater flow control facilities (2) Construct or retrofit stormwater infiltration facilities (4) Protect and increase forested areas in the watershed (5) Increase flow control facility inspections	(6) Add side channels	(11) Add instream complexity	(16) Clean streets (17) Construct or retrofit stormwater runoff treatment facilities (18) Provide education and outreach (20) Restore buffers (22) Increase runoff treatment facility inspections	

Hydraulic

Where Monticello Creek will remain in its existing channel, the City should construct side channels and add complexity to support salmon use.

Reach MC1A (Figure 5.7) should be moved from its current roadside ditch location to where the creek can be connected to adjacent wetlands.

Geomorphic

Recreate meandering creek channel segments in reaches MC1a and MC1b to create additional in-channel habitat with a dynamically stable channel form.

For all reaches of Monticello Creek, the channel should be enhanced to provide more instream habitat complexity and better support aquatic species. Creek channel design should consider the development potential in the watershed and the potential for reducing existing impacts.

Once flow control is improved in Reach MC2, creek banks should be stabilized.

The City will use grade control in Reach MC1b to add habitat complexity to the creek channel to slow high flows, and sort streambed sediments.

Physicochemical

Pollutant source control inspections are also recommended for all reaches in the limited locations where businesses exist in this watershed.

Roads in this watershed should be targeted for more frequent sweeping to reduce pollution before it enters the creek.

Improving stormwater quality in the Monticello watershed will improve aquatic habitat but is not as critical a concern as in other watersheds such as Evans Creek. That is because over 60 percent of the watershed is residential development, which typically equates to cleaner runoff. However, steps should still be taken to reduce risk from stormwater pollution. In cases where runoff treatment facilities are nonexistent, the City should look for opportunities to retrofit stormwater systems with treatment capabilities. Areas that are not residential, and roads specifically, should be the focus of retrofit projects. Transferring water quality treatment areas to this watershed in accordance with Chapter 4.2.3 of this plan is recommended.

Public outreach will be used to educate residents about ways they can reduce or eliminate water pollution from home activities.

Use in-field or lab testing to trace pollution in stormwater conveyance in Reach MC1. Once located, control source as appropriate, such as requiring structural or operational source control measures.

For portions of the creek that are not being moved, restoring a buffer with a tree canopy to shade the creek will improve water quality in the creek. A forested buffer will improve chronic low dissolved oxygen and high temperature conditions during summer months.

All reaches of Monticello Creek are in need of buffer enhancement or restoration to control invasive plants in addition to assisting with the water quality issues documented by the TMDL.

For all reaches, increase inspection frequency of both public and private facilities if a facility frequently requires cleaning during routine NPDES permit required inspections.

Biologic

Removal barriers to fish passage in reaches MC1a, MC1b, and MC2.

5.3.2.6 Tosh Creek

Figure 5.8 illustrates future land use in the Tosh Creek Watershed, the recommended route for relocating a portion of the creek channel, and illustrates the individual reaches of the creek within Redmond. The recommended set of watershed rehabilitation tools for each reach is provided in Table 5.7.

Tosh Creek watershed is currently mostly built out single-family residential but has higher redevelopment potential in the headwater portion of the watershed that accommodates commercial and multi-family uses. The watershed has been built out for decades, and many developed areas have little or no stormwater controls. This creek is a priority for restoration because it has limited stormwater outfalls and intact buffers along most of the creek. Tosh Creek has high fecal coliform concentrations but does not suffer from high temperature or low oxygen. This is because it has significant groundwater contributions that provide base flows similar to watersheds with outwash soils that are two to three times as large (NHC 2012). Once fish barriers are removed and this plan is executed, Tosh Creek will provide some of the best creek habitat in the Sammamish River system.

Recommended watershed and stream rehabilitation tools for improving this watershed are listed below in their respective stream functions pyramid categories.

Hydrologic

The upper reaches of Tosh Creek are impacted by high stormwater flows. Retrofitting the watershed area that contributes to the upper reaches will address flashy flows in the entire creek. Redevelopment in portions of the upper watershed is likely. During redevelopment, flow controls that meet current standards should be required.

Infiltration will be used to reduce hydrologic changes to the extent feasible. The entire watershed is 39 percent impervious, which is above the 30 percent threshold that typically indicates a degraded watershed. In no case should the City allow more impervious surface area in the upper watershed. Transferring flow control areas to this watershed in accordance with Chapter 4.2.3 of this plan is recommended.

For reaches TO2a, TO3a, and TO4a, inspect, and require maintenance and cleaning of private flow control facilities not designed to current standards, and increase inspection frequency of both public and private facilities if facility frequently requires cleaning during the routine inspections required by the City’s NPDES permit.

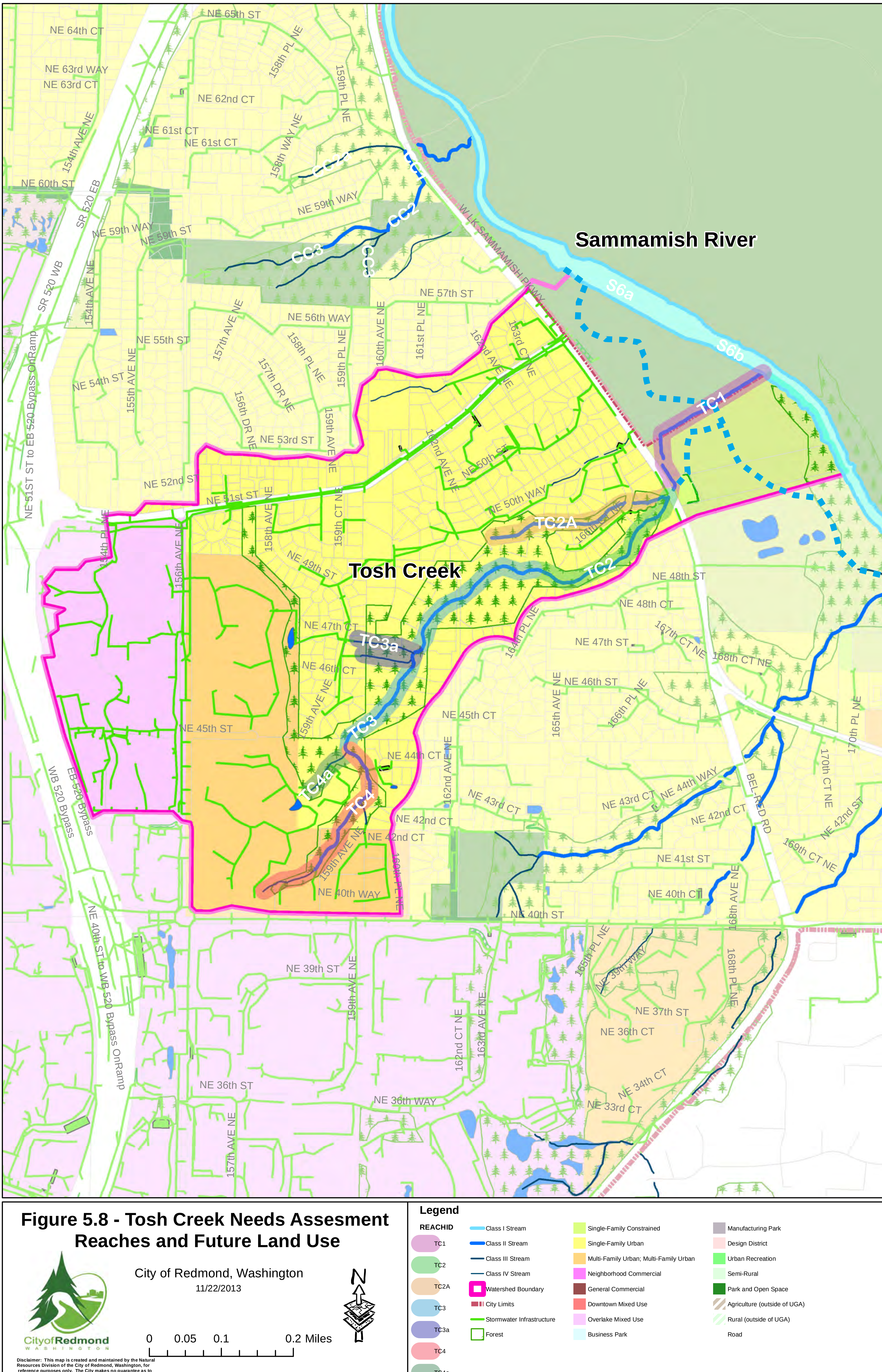

Figure 5.8 - Tosh Creek Needs Assesment Reaches and Future Land Use

City of Redmond, Washington

11/22/2013

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Table 5.7. Tosh Creek Watershed Rehabilitation Strategies.							
			Highest Priority------→------→------→------→------Lowest Priority				
Reach	Description of Current Conditions/Problems/Land Use	Future Land Use	1 – Hydrologic	2 – Hydraulic	3 – Geomorphic	4 – Physiochemical	5 – Biologic
TC1	Incised, gravel starved, low gradient, invasive riparian vegetation, channelized, two partial fish barriers	Park and open space	(4) Protect and increase forested areas in the watershed	(6) Add side channels (7) Relocate and/or reconnect creek, tributaries, riparian wetlands, floodplain	(10) Re-meander creek channel (11) Add instream complexity (12) Supplement instream gravel	(20) Restore buffers	(24) Remove fish barriers
TC2	Confined channel, narrow buffers, no stormwater outfalls	Single family urban	(4) Protect and increase forested areas in the watershed		(11) Add instream complexity (13) Stabilize banks	(18) Provide education and outreach (21) Enhance buffers	
TC3	Broad well forested buffers, many seeps, shallow groundwater, high sediment load from TC3a	Single family urban			(11) Add instream complexity	(21) Enhance buffers	
TC4	Narrow buffers, invasive riparian vegetation, several small stormwater outfalls, minimal flow control, minimal runoff treatment, minimal infiltration in watershed	Confined from multi-family urban development	(1) Construct or retrofit stormwater flow control facilities (2) Construct or retrofit stormwater infiltration facilities (4) Protect and increase forested areas in the watershed (5) Increase flow control facility inspections		(11) Add instream complexity (12) Supplement instream gravel (13) Stabilize banks (14) Add grade control	(15) Perform source control inspections (16) Clean streets (17) Construct or retrofit stormwater runoff treatment facilities (21) Enhance buffers (22) Increase runoff treatment facility inspections	
TC2a	One full fish barrier, limited stormwater inputs, relatively intact buffer	Single family urban	(1) Construct or retrofit stormwater flow control facilities (2) Construct or retrofit stormwater infiltration facilities (4) Protect and increase forested areas in the watershed (5) Increase flow control facility inspections		(11) Add instream complexity	(17) Construct or retrofit stormwater runoff treatment facilities (18) Provide education and outreach (21) Enhance buffers (22) Increase runoff treatment facility inspections	(24) Remove fish barriers
TC3a	Heavily incised, impacts lower reaches due to export of fines, receives runoff from single and multi-family urban and neighborhood commercial, receives high volume of stormwater runoff	Single and multi-family urban and neighborhood commercial	(1) Construct or retrofit stormwater flow control facilities (2) Construct or retrofit stormwater infiltration facilities (4) Protect and increase forested areas in the watershed (5) Increase flow control facility inspections		(9) Re-grade banks (13) Stabilize banks (14) Add grade control	(15) Perform source control inspections (16) Clean streets (17) Construct or retrofit stormwater runoff treatment facilities (18) Provide education and outreach (21) Enhance buffers (22) Increase runoff treatment facility inspection	
TC4a	Narrow buffers, invasive riparian vegetation, one problem stormwater outfall from undersized pond, minimal flow control, minimal runoff treatment, minimal infiltration in watershed, channel armored with spall, visible water quality issues	Confined from multi-family urban development	(1) Construct or retrofit stormwater flow control facilities (2) Construct or retrofit stormwater infiltration facilities (4) Protect and increase forested areas in the watershed (5) Increase flow control facility inspections		(11) Add instream complexity (12) Supplement instream gravel (13) Stabilize banks	(15) Perform source control inspections (16) Clean streets (17) Construct or retrofit stormwater runoff treatment facilities (18) Provide education and outreach (21) Enhance buffers (22) Increase runoff treatment facility inspections	

Hydraulic

Design and install side channels in Reach TC1 for fish use during storm events. Side channels will be designed to provide diverse aquatic habitat.

Tosh Creek currently is located in a ditch leading to the Sammamish River east of Westlake Sammamish Parkway. Reach TC1 (Figure 5.8) should be moved from its current ditched location to reduce flooding, improve natural sediment transport, and to reconnect the creek with the Sammamish River in a fish-friendly manner. This is one of the key projects recommended for this watershed.

Geomorphic

In Reach TC3a, reduce the slope of the channel banks to provide additional channel storage, reduce high velocity flows, and increase habitat diversity.

In Reach TC1, recreate meandering creek channel segments that are currently straight in order to create additional in channel habitat with a dynamically stable channel form.

The new channel for Tosh Creek will be designed to provide aquatic habitat complexity in virtually all reaches with the possible exception of Reach TC3 due to its heavily incised condition. King County also plans to accommodate improvements to Tosh Creek in the design for the redevelopment of the Willowmoor transition zone in Marymoor Park.

In reaches TC1 and TC4a, supplement gravel in the stream channel.

Stabilize banks in reaches TC2, TC4, TC3a, and TC4a once additional flow control is provided in the watershed.

Add grade control in Reach TC4 to add habitat complexity to the creek channel, slow high flows, and sort streambed sediments.

Physicochemical

Perform source control inspection in reaches TC4, TC3a, and TC4a of businesses to help reduce pollutants from entering stormwater runoff.

Increased street cleaning is recommended for reaches TC3a and TC4a in this watershed.

Stormwater quality impacts are a concern in the upper reaches of this creek. Retrofitting existing development in reaches TC4, TC2a, TC3a, and TC4a with runoff water quality treatment facilities will be necessary to improve conditions. Transferring water quality treatment areas to this watershed in accordance with Chapter 4.2.3 of this plan is recommended.

Continuing to monitor water quality directly (and by analyzing benthic insects) in this watershed will help the City assess the success of watershed rehabilitation projects to restore the creek's beneficial uses into the future.

It is important to retain the forested buffer areas that remain in all reaches of Tosh Creek to protect water quality and aquatic habitat.

Where the watershed is mostly residential in reaches TC2a, TC3a, and TC4a, a public education and outreach program will be developed to inform residents on what they can do, or refrain from doing, to help the creek support aquatic life.

Much of the buffer is intact, but a significant effort is still needed to control invasive weeds and supplement the existing conifer forest. This is the case for all the existing buffer areas in the watershed. Preserving and enhancing the buffer will prevent future water quality issues in the creek.

For reaches TC2a and TC4a, increase inspection frequency of both public and private facilities if a facility frequently requires cleaning during routine NPDES permit required inspections.

Biologic

Remove barriers to fish passage in reaches TC1 and TC2a early in the plan implementation as this creek already supports salmon use.

5.3.3 Restoration Watersheds

Watersheds with streams that are more degraded than Highest Restoration streams but still have potential to support beneficial uses with substantial investment are included in this management strategy group. These watersheds have impaired water quality, stream corridors are typically only partially intact, and instream complexity is limited compared to Highest Restoration streams. Salmonid use may be historically significant in these waterbodies, but typically has diminished.

Restoration watersheds include Redmond's portion of the Sammamish River watershed, a Class I waterbody. Other Restoration watersheds are associated with Perrigo Creek, Peters Creek, Tyler's Creek, and Wllows Creek, which are Class II creeks. Due to the unique value of the Sammamish River for salmon recovery, and the amount of investment planned to be made in the Sammamish River watershed in the near term, a greater level of detail is provided for the Sammamish River watershed than those associated with the Class II creeks. This includes a map detailing the reaches as delineated in the Chinook Salmon Recovery Plan and future land use, a table recommending the restoration tools needed to restore each reach, and a detailed write up. A narrative and map is provided for each of the remaining Restoration watersheds.

5.3.3.1 Sammamish River

The Sammamish River bisects the City of Redmond and is an important community focus (Figure 5.9). When the Howard Chittenden Locks were constructed in the early 20th century to create a passage from Puget Sound to Lake Washington, the hydrologic and hydraulic functions of the Sammamish River were forever changed. Then, in the mid-20th century, King County and the US Army Corp of Engineers dredged and straightened the Sammamish River, and constructed a concrete weir at the headwaters. The project essentially eliminated flooding in the Sammamish River valley, and reduced maximum flood elevations and seasonal water surface elevations in Lake Sammamish. The weir was modified in 1998 to improve passage for anadromous salmon during low flows.

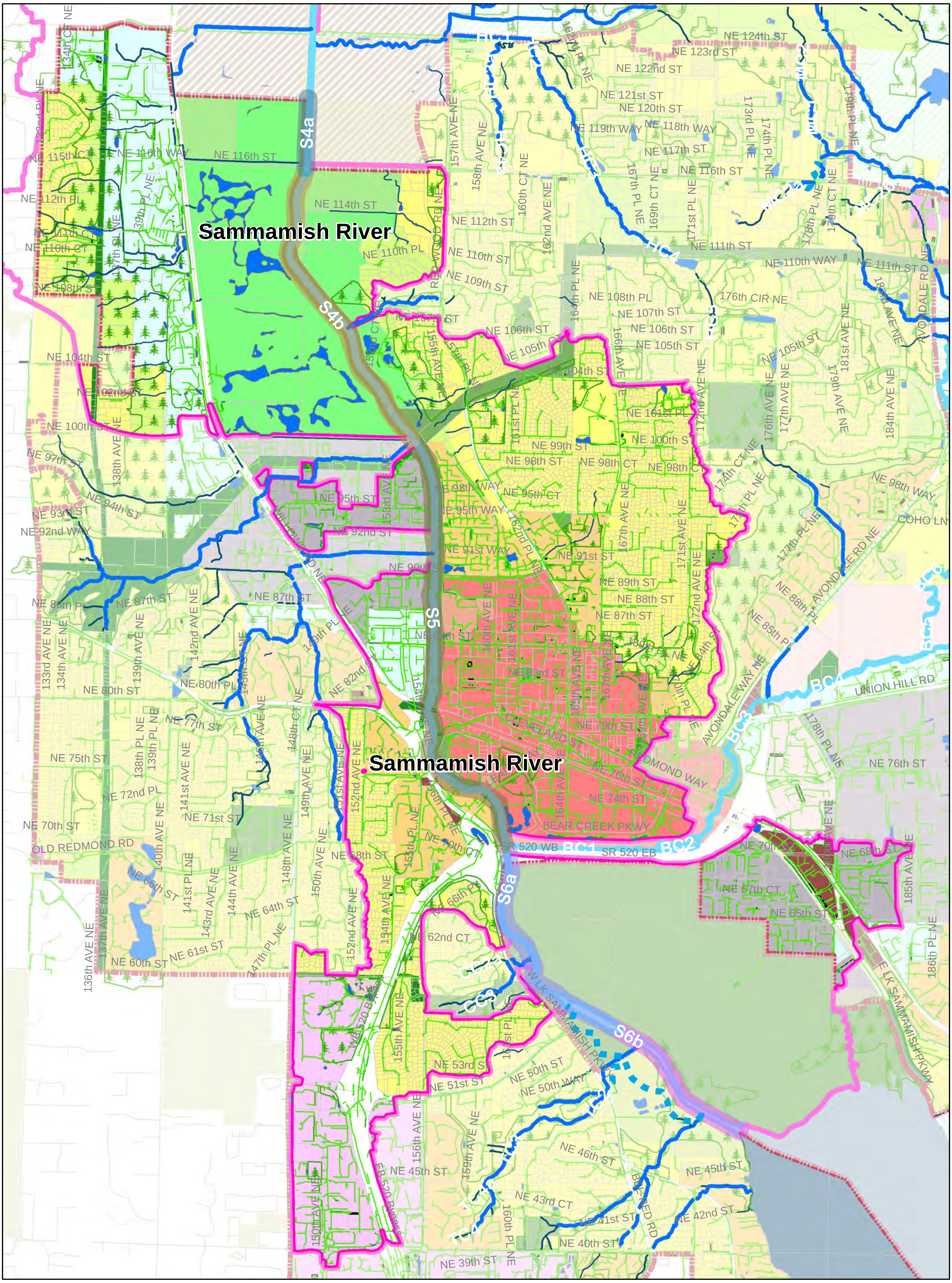

Figure 5.9 - Sammamish River Needs Assesment Reaches and Future Land Use

City of Redmond, Washington

11/22/2013

City of Redmond
WASHINGTON

0 0.125 0.25 0.5 Miles

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Disclaimer: This map is created and maintained by the Natural Resources Division of the City of Redmond, Washington, for reference purposes only. The City makes no guarantee as to the accuracy or completeness of the features shown on this map.

Legend

REACHID

- S4a
- S4b
- S5
- S6a
- S6b

- Class I Stream
- Class II Stream
- Class III Stream
- Class IV Stream
- Watershed Boundary
- City Limits
- Stormwater Infrastructure
- Forest

- Single-Family Constrained
- Single-Family Urban
- Multi-Family Urban; Multi-Family Urban
- Neighborhood Commercial
- General Commercial
- Downtown Mixed Use
- Overlake Mixed Use
- Business Park

- Manufacturing Park
- Design District
- Urban Recreation
- Semi-Rural
- Park and Open Space
- Agriculture (outside of UGA)
- Rural (outside of UGA)
- Road

Despite these historical disturbances, the Sammamish River remains a critical migratory waterbody for the Lake Sammamish and Bear Creek salmon runs, and is habitat for many aquatic species. However, high temperatures during river low flows and the lack of refugia during high flows limits its use for fish migration. In addition to rehabilitation measures focused on improving these conditions in the Sammamish River, measures to rehabilitate tributary creeks would also help improve migratory habitat within the Sammamish River watershed. Finally, the Sammamish River channel banks have been dominated by invasive plants ever since the river was straightened. King County and the City of Redmond have invested millions on buffer restoration projects, as well as one project in Redmond to recreate a meander in the river and improve instream complexity. Similar projects are still needed to improve water quality and habitat in the Sammamish River watershed.

Each stream function, and the actions needed to restore that function, is detailed below. Additional information on tools recommended for specific reaches can be found in Table 5.8.

Hydrologic

The City of Redmond requires that clean runoff be infiltrated to the extent possible in the upstream portions of the river, where the City utilizes groundwater as a drinking water source. Financial incentives have been codified to encourage redevelopment projects to infiltrate clean runoff.

Hydraulic

It is recommended that projects be implemented to reconnect oxbow side channels and floodplains with the Sammamish River to provide refugia for fish and additional flood capacity along the Sammamish River corridor.

Geomorphic

Rehabilitation measures for the Sammamish River should address increasing instream complexity including sediment removal, creating pools, gravel supplementation, and large wood placement. Redmond completed a significant instream complexity project in 2006, and other similar projects are either planned or in design for the remaining reaches of the river in Redmond.

Physiochemical

The majority of the watershed that drains directly to the Sammamish River has few or no runoff treatment facilities. Redmond is retrofitting over 500 acres of its highly developed commercial area and busiest streets with a regional runoff treatment facility. Additional runoff treatment facility retrofits would continue to improve water quality within the river.

In addition to stormwater impacts, the river is suffering from excessive heat and low dissolved oxygen in summer months. This is difficult to address because the north to south alignment of the straightened channel limits the amount of shade provided by planting trees in the buffers. Regardless, planting trees along the buffers, and restoring the buffers with native vegetation, would provide some needed relief from thermal impacts on the Sammamish River.

Reaches S5 and S6a would benefit from Ecology permit site support where the City would work with the state permitted stormwater facilities to annually review their SWPPP and pollution prevention measures, to provide technical support, and potentially fund solutions to existing water quality issues.

Biologic

The Sammamish River has one partial fish barrier that is the concrete weir installed at the river's headwater to control the elevation of Lake Sammamish. The current weir has one notch in the middle of the weir for fish to pass to access Lake Sammamish. King County is currently working on a design to replace the weir and efforts should be made to make the weir replacement fish passible at all flows.

5.3.3.2 Perrigo Creek

The Perrigo Creek watershed (Figure 5.10) is mostly within Redmond city limits and drains to the right bank of Bear Creek downstream of the Bear and Evans Creek confluence. Perrigo Creek has relatively good water quality but has heavily impacted buffers and much of it is ditched or piped where it is adjacent to Avondale Road. The opposite side of the creek channel is flanked by a large wetland complex that is undergoing restoration as part of mitigation for improvements to SR 520. Perrigo Creek will provide salmonid habitat in the greater Bear Creek watershed once the following actions are taken to restore the creek.

Hydrologic

Most developed areas within this watershed do not have flow control facilities. In addition, opportunities to infiltrate runoff in this watershed should be explored. Many cold water seeps contribute runoff to Perrigo Creek and those seeps would be better protected into the future if more infiltration occurs in this watershed.

Hydraulic

Plans to remove Perrigo Creek from the ditched and piped alignment, and create a new channel that would allow the creek to migrate would greatly improve hydraulic conditions in the creek.

Geomorphic

As with hydrologic and hydraulic functions, geomorphic functions would also benefit from moving and rebuilding the channel. The rebuilt channel should include elements critical to geomorphic function such as woody debris, pools, and higher instream complexity.

Physiochemical

Most of the development in the watershed is lacking stormwater runoff treatment facilities and these should be added. In addition, replanting buffers with shade producing trees would help lower summer water temperatures.

Biologic

Fish barriers in Perrigo Creek should be removed.

Table 5.8. Sammamish River Watershed Rehabilitation Strategies.							
			Highest Priority→	→	→	→	Lowest Priority
Reach	Description of Current Conditions/Problems/Land Use	Future Land Use Designation	1 – Hydrologic	2 – Hydraulic	3 – Geomorphic	4 – Physiochemical	5 – Biologic
S6B	Channel Backwatered to Lake Sammamish elevation due to weir immediately downstream of this reach. Slow moving flows. Buffers are mostly wooded wetlands. Marymoor dog park access on right bank, Sammamish Rowing Club access on left bank. Country Creek and Tosh Creek enter Sammamish on left bank in this reach. Most of watershed on the eastside of the river is Marymoor Park and outside Redmond City limits. Small portion of City drains to this reach directly from the City, and enters a wetland prior to entering the river.	Single Family Urban Single Family Constrained	(1) Construct or retrofit stormwater flow control facilities (wetland standard) (4) Protect and increase forested areas in the watershed			(16) Clean streets (18) Provide education & outreach (21) Enhance buffers	
S6A	Concrete weir that controls flows from Lake Sammamish is in the most upstream part of this reach. Weir is a partial fish barrier with a narrow notch for fish passage. Transition zone downstream of weir has the steepest gradient in all of the Sammamish River. Banks are riprap and steep. Most of the banks have been replanted; however ongoing invasive control is needed.	Single Family Urban	(2) Construct or retrofit stormwater infiltration facilities (4) Protect and increase forested areas in the watershed	(7) Relocate and/or reconnect creek, tributaries, riparian wetlands, floodplain	(10) Re-meander channel (11) Add instream complexity	(17) Construct or Retrofit Stormwater Runoff Treatment Facilities (18) Provide education & outreach (20) Restore buffer (22) Increase runoff treatment facility inspections (23) Ecology Permitted Site Support	(24) Remove fish barrier
S5	Bear Creek confluence is on right bank of this reach. Major power line infrastructure crosses the river in this reach. About 50% of the buffers have been restored/replanted in this reach. Buffers are all under King County ownership in this reach. Most of the contributing watershed to this reach is developed and include large areas of commercial and industrial land uses. Multifamily and single family also present. Willows and Peters Creek enter the left bank in this reach.	Multifamily Downtown Mixed Use Business Park Single Family Urban	(2) Construct or retrofit stormwater infiltration facilities (4) Protect and increase forested areas in the watershed		(9) Re-grade banks (11) Add instream complexity	(15) Perform pollutant source control inspections (16) Clean streets (17) Construct or Retrofit Stormwater Runoff Treatment Facilities (18) Provide education and outreach (19) Track pollution sources (20) Restore buffers (22) Increase runoff treatment facility inspection (23) Ecology Permitted Site Support	
S4B	Willows Run Golf Course dominates the watershed on the west side of this reach. Soccer fields and single family low density development dominate the watershed on the west side of this reach. Tolt pipeline crosses underneath the river in this reach. Valley Estates Creek enters the right bank of this reach. Remnant oxbow still exists on the right bank of this reach. Portions of the buffers have been restored.	Urban Recreation Business Park Single Family Urban Park and Open Space	(2) Construct or retrofit stormwater infiltration facilities (4) Protect and increase forested areas in the watershed	(6) Add side channels	(9) Re-grade banks (11) Add instream complexity	(15) Perform pollutant source control inspections (18) Provide education and outreach (20) Restore buffers (22) Increase runoff treatment facility inspections	
S4A	Soccer fields and farm land flank both sides of this reach. Small non fish baring creeks enter the left bank of this reach near a remnant oxbow. Buffers are mostly restored with native vegetation.	Urban Recreation Business Park Single Family Urban Single Family Constrained	(2) Construct or retrofit stormwater infiltration facilities (4) Protect and increase forested areas in the watershed	(6) Add side channels	(9) Re-grade banks (11) Add instream complexity	(15) Perform pollutant source control inspections (16) Clean streets (17) Construct or Retrofit Stormwater Runoff Treatment Facilities (18) Provide education and outreach (19) Track pollution sources (22) Increase runoff treatment facility inspection (20) Restore buffers	

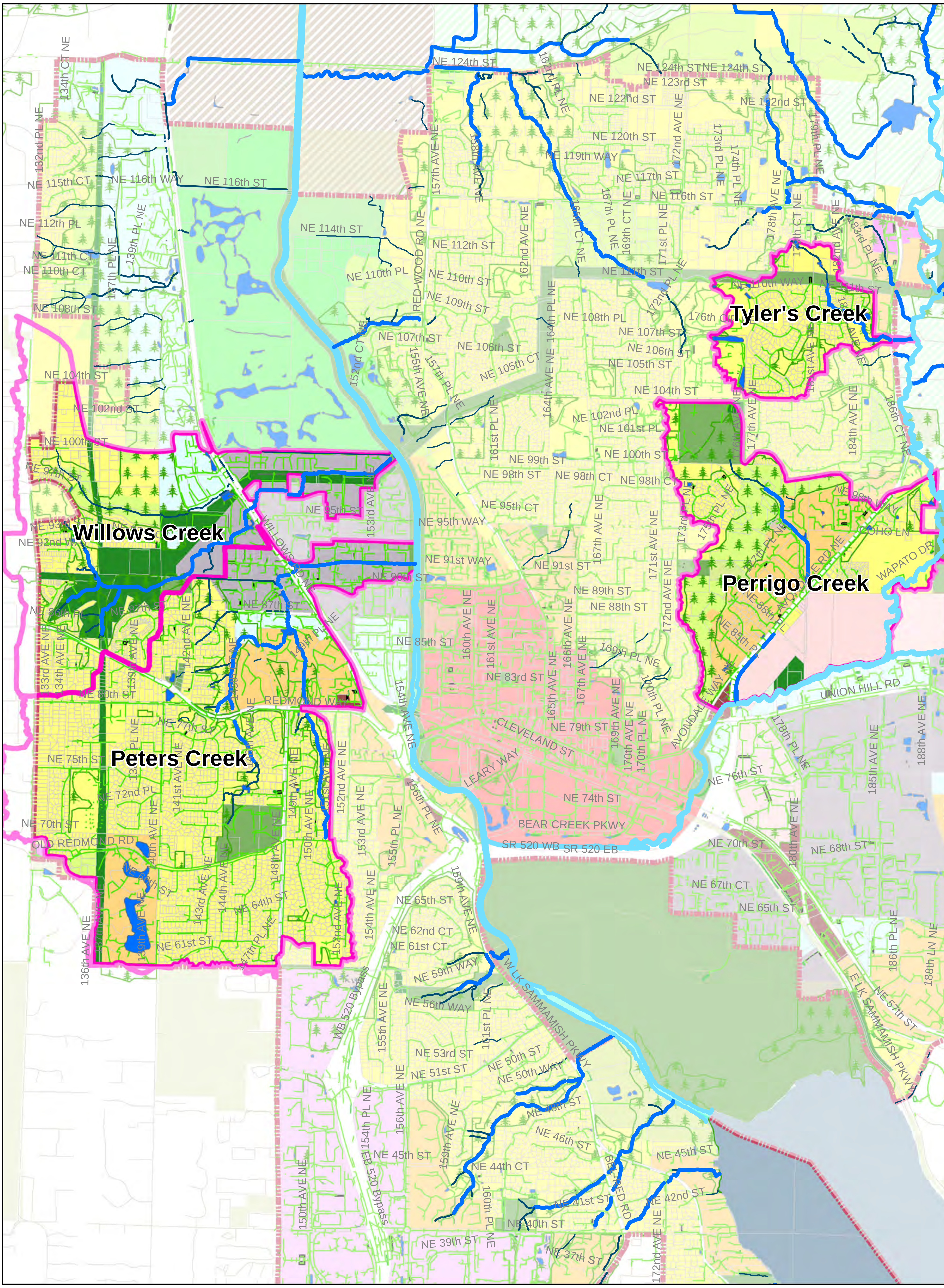

Figure 5.10 - Perrigo, Peters, Tyler's, and Willows Creeks and Future Land Use

City of Redmond, Washington

11/22/2013

0 0.25 0.5 Miles

N

City of Redmond WASHINGTON

Legend

Class I Stream	Single-Family Constrained	Manufacturing Park
Class II Stream	Single-Family Urban	Design District
Class III Stream	Multi-Family Urban; Multi-Family Urban	Urban Recreation
Class IV Stream	Neighborhood Commercial	Semi-Rural
Watershed Boundary	General Commercial	Park and Open Space
City Limits	Downtown Mixed Use	Agriculture (outside of UGA)
Stormwater Infrastructure	Overlake Mixed Use	Rural (outside of UGA)
Forest	Business Park	Road

5.3.3.3 Peters Creek

Peters Creek watershed is mostly within Redmond city limits (Figure 5.10). Peters Creek is one of Redmond's larger Class II watersheds and has had substantial investments made to improve the watershed to reduce stormwater impacts in the last 20 years.

Hydrologic

Most developed areas within this watershed do not have flow control facilities and these should be added. In addition, opportunities to infiltrate runoff in this watershed should be explored.

Hydraulic

There are no recommended hydraulic actions for Peters Creek.

Geomorphic

Peters Creek needs improved instream complexity. Instream complexity could be improved by regrading the channel to construct pools, setting back incised banks, and placing woody debris in the channel to increase habitat diversity.

Physiochemical

Most of the developed watershed is lacking stormwater runoff treatment facilities and these should be added. In addition, replanting buffers with shade producing trees would help moderate summer water temperatures. Education and outreach efforts to the homeowners in this watershed would help maintain existing and reestablished buffers.

Biologic

All fish barriers in Peters Creek should be removed.

5.3.3.4 Tylers Creek

Tylers Creek watershed is a small watershed (Figure 5.10). Tylers Creek enters the right bank of Bear Creek just outside Redmond city limits. This creek and watershed is significantly impacted from development of the watershed that occurred prior to sufficiently protective stormwater management regulations. Protection of the riparian buffers was also below current standards and has resulted in existing development encroaching on the creek channel.

The lower reach of Tylers Creek within Redmond has some intact forested buffers. The power line trail and corridor occupies a portion of the northern watershed.

Each stream function, and the actions needed to restore that function, is detailed below.

Hydrologic

Most developed areas within this watershed lack stormwater flow control facilities, which should be added. In addition, opportunities to infiltrate runoff in this watershed should be explored.

Hydraulic

No hydraulic issues or needed actions to remedy hydraulic issues are identified for this watershed.

Geomorphic

Tylers Creek needs improved instream complexity, which could be accomplished by regrading the channel to construct pools, setting back incised banks, and placing woody debris in the channel to increase habitat diversity.

Physiochemical

Most of the developed watershed needs stormwater runoff treatment facilities. In addition, replanting buffers with shade producing trees would help lower water temperature, especially during low flow periods. Last, retrofitting the NE 116th Street with stormwater treatment facilities would significantly reduce the untreated stormwater runoff entering Tylers Creek.

Biologic

All fish barriers in Tylers Creek should be removed.

5.3.3.5 Willows Creek

Willows Creek watershed is mostly within Redmond city limits (Figure 5.10). Although small and heavily impacted with fish barriers in the lower reaches, water quality and hydrology in the City's portion of Willows Creek is relatively good considering the level of EIS, and pollution generating surfaces and activities in the lower reaches. The upper reaches include pockets of residential development with large native vegetation set asides and lot clustering. Willows Creek watershed has been home to business parks and light industrial land uses for decades. The upper reaches include large forested areas on steep slopes that are not conducive to development.

Hydrologic

Most developed areas within this watershed do not have flow control facilities and they should be added. In addition, opportunities to infiltrate runoff in this watershed should be explored.

Hydraulic

A large wetland area near the power substation in Redmond is dominated by reed canarygrass, which causes the creek channel to braid and restricts fish from using the creek upstream of the braided reach. The reed canarygrass should be removed or an alternative channel constructed to allow for fish passage.

Geomorphic

Instream channel complexity is poor; projects should target instream improvements such as installing large woody debris, creating pools, and adding substrate material that can provide a diversity of habitat.

Physiochemical

Most of the developed watershed lacks stormwater runoff treatment facilities and these should be added. In addition, replanting buffers with shade producing trees would help moderate summer water temperatures.

Biologic

All fish barriers along Willows Creek should be removed.

5.3.4 Restoration Development Watersheds

Watersheds with streams significantly compromised in both the stream corridor as well as extensive impacts caused by watershed development are in the category of Restoration Development Watersheds. Six of Redmond's 20 watersheds have been placed in this category. Included are the watersheds for Country, Idylwood, Sears, Valley Estates, and Villa Marina creeks as well as Lake Sammamish.

Most of the land cover in these watersheds is either landscaping or EIS. None of the streams in this category currently support significant salmonid use; however, Lake Sammamish supports a number of species including Chinook and coho. The Restoration Development Watersheds are limited in their near-term potential to provide salmonid habitat, they require substantial and costly improvements. As a consequence, effective rehabilitation measures for these waterbodies are limited in the short term but will be specifically addressed once near term plan objectives are met in future updates to this WMP.

Although this first 5-year plan is not focused on these watersheds its critical to make clear that all waterbodies in Redmond are important to the City, all waterbodies will not be degraded from current conditions, and all waterbodies are planned to be restored to fully support beneficial uses by 2105.

It's also important to note that ongoing efforts and investments unrelated to this plan will continue in these watersheds. For example, although Sears Creek watershed is not a priority for restoration at this time, $35 million of regional stormwater retrofits are underway to support redevelopment of the Sears Creek watershed into the Overlake regional urban growth center. Idylwood Creek was recently retrofitted with a high-flow bypass and over $2 million of instream and buffer improvements were made along the riparian corridor, downstream of the bypass. In addition to these activities at Sears and Idylwood creeks, many regional efforts will continue to address phosphorous reductions to Lake Sammamish as well as efforts to restore natural shorelines along the lake.

These examples are provided to illustrate that even though the Restoration Development Watersheds are not currently a high priority, the City is committed to diligently protect them from further degradation.

Chapter 6 Implementation Strategy

This chapter outlines implementation for this WMP and covers the following elements:

- Guidance is provided for selecting BMPs for rehabilitation efforts that provide multiple benefits (or *value stacking*) as a means of increasing their overall environmental and social value.
- Planned adaptations in response to climate change are identified.
- A funding strategy to support implementation of this plan is discussed.
- An overview of a monitoring program is provided that will evaluate the effectiveness of this WMP.
- An adaptive management strategy is outlined to evaluate, update, and refine this WMP over time based on instituted feedback mechanisms for performance.

- **Rehabilitation tool selection is guided by delivery of multiple benefits contributing to environmental goals.**
- **Planned adaptation measures will increase the City's resilience to climate changes.**
- **A funding strategy will support implementation of the WMP.**
- **Specific program tools will facilitate adoption of the WMP.**
- **A monitoring program will evaluate WMP effectiveness.**
- **An adaptive management strategy will evaluate, update, and refine this WMP based on instituted feedback mechanisms for performance.**

6.1 BMP Selection Guidance

The watershed rehabilitation strategies recommended specific stream and watershed rehabilitation tools (Table 5.1) for each watershed. As the City of Redmond moves into implementation of this WMP, identifying the best suite of BMPs to satisfy the goals and constraints of each rehabilitation tool will be critical. Criteria for BMP selection will consider the following:

- **Benefit** – This will include stormwater management, ecosystem services, and community livability.
- **Cost** – Capital and operational costs will be evaluated.
- **Implementation** – Ease of implementation (primarily an issue of time) will be evaluated.

- **Ownership and Management** – Issues related to public versus private ownership and management will be considered.

Well-crafted watershed management plans seek to optimize this distinction to maximize the return on every public dollar invested in stormwater management. As the City of Redmond moves into implementation of this watershed management plan, each BMP associated with a rehabilitation tool will be evaluated to maximize the benefits provided through its implementation to achieve not only watershed goals but also additional community, financial and environmental goals.

Generally, traditional or *grey infrastructure* BMPs provide a single benefit solution where *green infrastructure* BMPs provide a multiple benefit solution. Green infrastructure BMPs use natural systems (or systems engineered to mimic natural processes) to manage stormwater near its source. In the process, they deliver many other environmental, social, and economic benefits that ultimately contribute to a sustainable community. This is an important distinction to understand while selecting BMPs because green infrastructure-based watershed strategies allow a simple stormwater investment to be leveraged into a higher value community enhancement solution because multiple benefits are provided. For example, an underground detention vault would provide the single benefit of flow control whereas a rain garden, depending on design, would provide not only flow control but also the multiple benefits of volume reduction, water quality improvement (TSS, nutrients, etc.), urban heat island reduction, habitat enhancement, property enhancement, and carbon sequestration. Appendix C presents a table that was reproduced from the CNT (2010), to illustrate the multiple benefits that can be obtained from several representative green infrastructure BMPs.

It is important to note, however, that green infrastructure is sometimes less effective than grey infrastructure in high flow systems. Green infrastructure, especially bioretention, does not have the ability to significantly reduce the high flow rates that cause stream channel erosion. If stream channel erosion is a major issue in a watershed, grey infrastructure, usually in the form of regional retention/detention ponds or vaults may be more effective in reducing the high flows causing the erosion. Conversely, if a stream channel does not display degradation due to high flows, but has too low of a flow, green infrastructure better addresses that impairment. In a watershed that has both high flow and low flow concerns, a combination of green and grey infrastructure will likely be necessary to restore hydrologic conditions sufficient to improve habitat.

6.2 Climate Change Adaptation

According to climate models for the Pacific Northwest, climate change is expected to bring an increase in both precipitation volume and intensity during the winter, and a decrease in precipitation during the summer (UWCIG 2005). Given these changes could directly impact the success of this WMP for rehabilitating water resources, the following sections discuss the anticipated effects on water resources in detail and the City's plans for minimizing them.

6.2.1 Predicted Climate Effects

Significant research on climate change predictions has been conducted by the Climate Impacts Group at the University of Washington. This research projects the local effects of global climate change using 20 global climate models and two emissions scenarios. Local climate impacts are identified by downscaling model results and supplementing data with regional climate models. The results indicate that future temperatures in the Pacific Northwest will increase, on average, 2.0ºF by the 2020s, 3.2ºF by the 2040s, and 5.3ºF by the 2080s, compared with the average from 1970 to 1999 (temperatures are averaged across all 20 climate models). This equates to rates of warming ranging from 0.2ºF to 1.0ºF per decade. As a result, evaporation and transpiration are likely to increase in the future, reducing the amount of water that is available to recharge groundwater during the summer months (Mote and Salathé 2010).

Projected changes in annual precipitation, averaged over all models, are small (1 to 2 percent), but most models project an enhanced seasonal cycle with changes toward wetter autumns and winters, and drier summers (Mote and Salathé 2010). Average projected winter increases in precipitation are not large relative to interannual variability (Littell et al. 2009). Projections of extreme precipitation events also vary significantly, but generally indicate increases in extreme rainfall magnitudes throughout the state in the future (Littell et al. 2009).

While changes in overall annual precipitation are not projected to be significant, the timing and character of precipitation is projected to change. Winters will bring more rain and less snow in the mountains. Summers will generally tend to be dryer, increasing susceptibility to flash floods as a secondary hazard from severe summer rainstorms. In addition, the probability of secondary hazards will increase, including saturated soil hazards such as landslides and falling trees.

Overall, climate change predictions indicate that storms in the northwest are likely to occur more frequently and be more severe. Currently Redmond receives just under 40 inches of precipitation on average per year, and snow is relatively rare occurring less than a week within each year. Given current climate change predictions, it is likely that Redmond can expect to receive more extreme precipitation events and potentially more snow in the winter months.

These predicted climate changes will alter precipitation patterns and, consequently, increase flood risk potential in the City. Increased average air temperature will produce increased average and summer water temperatures as well as higher evapotranspiration. Higher water temperatures will increase the frequency and duration of incidents of low dissolved oxygen; such incidents are already problematic in a number of the City's waterbodies such as the Sammamish River, Bear Creek, and Evans Creek.

Table 6-1 outlines the aspects of stormwater management that would be most affected by climate change in Redmond, and the resultant physical and biological responses. These responses are predicted based on the rain-dominated hydrology of the City.

The potential hydrologic changes associated with climate change increase the importance of stormwater management practices that control flows, promote infiltration, and preserve and enhance water quality. Because Redmond's water resources are precipitation driven and much of the City's water supply is from groundwater, ensuring infiltration of stormwater and groundwater recharge will become increasingly important as groundwater demands increase (due to higher temperatures and greater population), and especially if water resources become more scarce (due to altered precipitation patterns and higher temperatures).

Table 6-1. Predicted Climate Change Effects on Stormwater Flows.

Stormwater Element	Predicted Response to Climate Change
Storm intensity	Increased magnitude and frequency of peak flows
Annual precipitation amount and seasonal distribution	Moderate increase in winter precipitation Moderate decrease in summer precipitation Increased average runoff in winter and spring Decreased summer base flow
Flood risk	Increased flood risk from increased peak flow magnitudes Increased flood risk from channel migration
Water temperature	Increased average and summer water temperature Lower dissolved oxygen Increased algal blooms
Evapotranspiration	Increased evapotranspiration Lower soil moisture Reduced summer base flow in creeks Reduced groundwater recharge Wetland conversion from perennial to seasonal

Changes in the City's hydrologic patterns could have consequent effects on water quality. As average water temperature increases, it will likely exacerbate existing water quality problems of low dissolved oxygen and seasonally high temperatures. Such effects will adversely alter stream and lake ecosystems, affecting the viability of many native aquatic plant and animal species, especially cold-water fish such as salmon and cutthroat trout. These changes increase the importance of providing adequate water quality treatment at new and redevelopment projects, as well as retrofits of the City's existing system.

6.2.2 Climate Change Action Implementation Plan

In response to this and other climate change related concerns, the City is preparing a Climate Action Implementation Plan to identify the roles the City will play in reducing greenhouse gas emissions and adapting to a changing climate (City of Redmond 2010b). Aspects of this plan have mutual benefits for watershed management. These include restoring more areas of forested vegetation to absorb carbon dioxide, and provide shade and cooling; installing large woody debris in streams for increased habitat complexity that provides refugia; and promoting the use of LID to retain groundwater, maintain instream flows, reduce erosive flows, and protect water quality. The plan acknowledges that protecting and enhancing the City's natural areas not only supports climate change adaptation, but also provides these additional benefits, which support improved watershed management:

- **Salmon Protection**: Shade provided by trees along waterbodies benefits salmon and other species. Shade keeps water cooler, provides cover through light patterns, provides a source for large and small woody debris recruitment, and improves conditions for increased dissolved oxygen in the water that is necessary for salmon health and survival.

- **Reduced Urban Heat Island Effect**: According to the U.S. EPA, the term "heat island" describes developed areas that are hotter than nearby rural areas. Vegetation can help mitigate this impact by lowering surface water and air temperatures through shade and evapotranspiration. Shaded surfaces, for example, may be 20 to 45°F cooler than the peak temperatures of unshaded materials. Evapotranspiration, alone or in combination with shading, can help reduce peak summer temperatures by 2 to 9°F.

- **Ecosystem Services**: Ecosystem services are those benefits people obtain from the ecosystem. Street trees, vegetated bioswales, open space, and wetlands play an important role in protecting watersheds, including providing water purification, groundwater and surface flow regulation, erosion control, and stream bank stabilization. Protecting and enhancing the City's natural areas can provide the same services as expensive stormwater infrastructure at much lower cost and with added benefits to the community.

6.3 Funding Strategy

In 1988, the City established the Stormwater Management Utility (Utility) that is funded by utility rates and capital facilities charges. The current monthly utility rate was designed to fund various elements of the Utility with roughly 50 percent of the rate revenue used for maintenance and operations while the remaining 50 percent is used to fund various aspects of the capital program. The capital program uses 10 percent of rate revenues to fund system repair and replacement and 40 percent of rate revenues fund system improvements and upgrades. In addition to the utility rate, capital facilities charges are paid by all development. On top of the citywide facility charge, capital facility surcharge areas have been developed to retrofit Redmond's urban centers (Overlake and Downtown) with regional stormwater management facilities. The current citywide capital facility charge is $958 per 2,000 square feet of impervious surface. The regional facility surcharge for Overlake and Downtown is $8,539 and $5,435, respectively, per every 2,000 square feet of impervious surface.

Redmond City Council approves a stormwater utility 6-year capital improvement program (CIP) every 2 years, updating every biennium which projects will be built with the Utility rate revenue funds. The Council approved 6-year 2013-2018 Stormwater CIP was used to inform the following discussion.

Table 6.2 provides a summary of budgeted capital investments for instream and buffer projects, and stormwater retrofits from the 2013-2018 Stormwater CIP with the specific allocation for each watershed priority category: Protection, Highest Restoration, Restoration, and Restoration Development watersheds. The waterbodies and associated watersheds in each category are identified in Table 4.1 of this plan. The estimate provided is the average annual investment budgeted (from 2013 to 2018) for each watershed category.

As noted above, the 2013-2018 Stormwater CIP also includes large regional stormwater retrofit projects to support the redevelopment of Redmond's two urban centers: Overlake and Downtown. The Overlake stormwater retrofit will provide flow control for 364 acres that contribute runoff to Sears Creek. The Downtown stormwater retrofit will provide runoff treatment for 500 acres that contribute runoff to the Sammamish River. The Overlake stormwater retrofit is estimated at $45 million and the Downtown retrofit is estimated at $30 million. It is important to note that once this expense is incurred by the stormwater utility, the debt service on the two projects will greatly reduce the Utility's capital resources after 2018 unless additional revenue from state and federal sources are obtained or a stormwater rate increase is approved by the Council. Without additional revenue, stormwater and instream or buffer projects will likely occur at a reduced level of effort after 2018 relative to the 2013-2018 Stormwater CIP.

Table 6.2. Summary of Budgeted Capital Investments for the 2013-2018 Stormwater CIP.

Watershed Priority	Instream and Buffer Projects	Stormwater Runoff Treatment and Flow Control Retrofit Projects
Preservation Watersheds	$125,000	$0
Highest Restoration Watersheds	$4,000,000	$2,100,000
Restoration Watersheds	$500,000	$110,000
Restoration Development Watersheds	$0	$0

However, the investment in regional stormwater retrofit projects will not reduce funding for the Utility's programmatic activities. These include stormwater system maintenance and cleaning, street cleaning, education and outreach, pollutant source tracing, business inspections, and water quality monitoring.

In addition to the funding obtained through the Utility, the City will actively pursue grants and loans to fund different components of this WMP. Potential funding sources of this type include:

- Centennial Clean Water Program from Ecology
- Clean Water Act Section 319 Grant Program from the U.S. EPA
- Clean Water State Revolving Fund Loan Program from Ecology and the U.S. EPA
- Stormwater Retrofit and LID Program from Ecology
- Puget Sound Watershed Protection and Restoration Program from the U.S. EPA and PSP

6.4 Effectiveness Monitoring Plan

Many facets of the WMP will be tracked over time to determine the extent to which it is being implemented and used to guide decisions. However, the ultimate goal of this WMP is to rehabilitate the waterbodies in watershed prioritized for Highest Restoration. Without monitoring trends in the associated streams in response to improvements made through this WMP, it will not be possible to demonstrate empirically that the City's actions were effective at achieving the goal of restoring these watersheds. Therefore, an Effectiveness Monitoring

Plan has been developed as a companion document to this WMP for evaluating long-term trends in the City's streams. A brief summary of this Plan is presented herein while the entire document is provided in Appendix D of this WMP.

It is anticipated that monitoring pursuant to the Effectiveness Monitoring Plan will occur at a total of six locations at any given time on the 16 Class II streams identified in Figure 3.14:

- Two reference sites to be established in watersheds prioritized for Protection
- Two control sites established in watersheds prioritized for Restoration Development
- Two treatment sites established in watersheds prioritized for Highest Restoration

Appropriate indicators for sampling will be measured pursuant to the Effectiveness Monitoring Plan to evaluate trends in stream flow and water quality. The Effectiveness Monitoring Plan will also incorporate more general indicators of habitat quality (for example B-IBI scores derived from benthic macroinvertebrate data).

Using the data obtained from this monitoring, the effectiveness of the WMP will be tested against the following specific goals of this WMP:

- Waterbodies in all Protection watersheds will continue to meet water quality standards; the goal is to retain their condition.
- Waterbodies in all Highest Restoration watersheds will be rehabilitated by 2060. This means they will meet water quality standards and progress from fair (26 to 37) to good (38 to 45) in terms of B-IBI scores. This performance goal also directly addresses the PSP's ecosystem recovery targets for Puget Sound to improve mean B-IBI scores for 30 Puget Sound watersheds from fair to good (PSP 2011a).
- Waterbodies in all Restoration Development watersheds will exhibit no signs of increased impairment and show signs of improvement once rehabilitation efforts initiate.

An adaptive management approach will be applied in the evaluation of the data from this monitoring program to ensure these goals are met (see discussion in next subsection).

6.5 Adaptive Management Strategy

The City will implement an Adaptive Management Strategy that will entail evaluating and refining this WMP based on instituted feedback mechanisms. The Adaptive Management Strategy will look at two separate but related questions:

- Is the WMP being implemented as intended?
- Are the rehabilitation goals for streams being met?

To evaluate whether the WMP is being implemented as intended, the City will identify and review all major capital projects and land use planning decisions referenced in this WMP each year. For each project or land use decision a series of questions will be answered, such as:

- Were water resource impacts or improvements considered as part of the project or decision?
    - If no, why not?
    - If yes, what actual modifications were made pursuant to this WMP?
- Were the highest rehabilitation priority watersheds considered (either directly or indirectly) in these modifications?
- What BMPs or design elements were considered or selected that met citywide goals of rehabilitating or protecting watersheds while also creating a more livable city?

In addition to the evaluation of development projects, the annual evaluation will include a specific assessment and summary of activities in each of the priority watersheds. Clearly, the type and number of activities implemented should inform expectations of water resource improvements in these watersheds.

If this annual assessment indicates that the WMP is not being effectively used to guide efforts, then City staff must evaluate why. For example, they will need to consider whether there are obstacles to implementation, whether there are elements that are impractical to implement or track effectively, or whether there is not enough incentive to garner support for these efforts. The City will use this evaluation to revise the WMP implementation approach so that it becomes more effective through time.

The Adaptive Management Strategy also includes an evaluation of the results from the Effectiveness Monitoring Plan (see previous subsection) at 5-year intervals. If the evaluations indicate that the interim goals set for individual streams (e.g., rehabilitate all waterbodies in Highest Restoration watersheds by 2060) are not being met, the City will need to evaluate whether there are problems with plan implementation (as described above), insufficient capital funding, or whether rehabilitation activities have been ineffective.

In concert, the annual assessments will help to reinforce rehabilitation efforts and the focus of the WMP, while the 5-year assessments of the effectiveness monitoring data will be used to determine whether WMP goals are on track. The City will modify priorities and redirect efforts in response to these assessments.

Lastly, this WMP will be updated every 5 years based on the information obtained from the adaptive management strategy, changes in regulatory drivers, and the City's overall achievements, priorities and objectives for managing future growth.

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APPENDIX A

Letter of Support from Washington State Department of Ecology

STATE OF WASHINGTON
DEPARTMENT OF ECOLOGY
Northwest Regional Office • 3190 160th Ave SE • Bellevue, WA 98008-5452 • 425-649-7000
711 for Washington Relay Service • Persons with a speech disability can call 877-833-6341

June 20, 2013

Mr. Andy Rheaume
City of Redmond
P.O. Box 97010
Redmond, WA 98073-9710

RE: Request for Review and Letter Supporting *City of Redmond Watershed Management Plan (WMP) (Draft 2013)*

Dear Mr. Rheaume:

Thank you for the opportunity to review the *City of Redmond Watershed Management Plan (Draft 2013).* Ecology appreciates the City's collaborative approach to developing this innovative plan. We recognize Redmond's commitment to fully implement the requirements of the Western Washington Phase II Municipal Stormwater Permit and to maintain and restore healthy habitats and ecosystems within the City.

Per your request, Ecology staff with stormwater permit management, engineering and water quality restoration expertise reviewed the draft report. In all, we find it to be a thoughtful, careful, and strategic approach to protecting the City's vital natural resources. Specifically, we note the following strong features of the approach:

- The WMP establishes a prioritization scheme that directs stormwater management improvements to those watersheds within the City where they will provide the most immediate environmental benefit (e.g, to support and rehabilitate fish resources or address known water quality problems). The prioritization scheme tracks closely with other regional prioritization approaches and focuses actions where the City has control and an ability to affect overall water quality. We understand that the Washington Department of Fish and Wildlife also reviewed the draft WMP and came to the same conclusion.
- Off-site facilities will be constructed <u>before</u> any developer is allowed to "pay in."
- The WMP states explicitly that "in no case will stormwater runoff from [any] development be allowed to further degrade conditions in a receiving water." (p.93)
- The City will establish dedicated flow control and water quality mitigation funds to manage "fee-in-lieu payments" contributed by developers. These restricted funds

will be managed separately from other capital funds and will not be used to build habitat projects.

- The WMP will include a tracking mechanism to ensure that adequate offsite water quality or flow control improvements are established and to ensure that any necessary stormwater treatment or flow control facilities constructed in priority watersheds are completed before developers "pay into" the site.
- The City, generally, will assume all operations and maintenance responsibility for those offsite facilities developed in priority watersheds, thereby assuring their continued functionality.
- The City will conduct effectiveness monitoring to assure that projects undertaken onsite or in priority watersheds are providing the anticipated water quality and environmental improvements or benefits. When/where the monitoring indicates that water quality goals are not being met, the City commits to implement an adaptive management strategy to refine the WMP.
- The City acknowledges that it must take responsibility for any future water quality impacts in the receiving water, even after implementation of the WMP.
- The WMP establishes a strong foundation for developing watershed-specific water strategies and schedules to address known water quality impairments. When the city begins implementation in these specific watersheds, the work may meet the criteria for placement into category 4b of the Washington Water Quality Assessment.

We remind the City that Ecology will not allow new or increased impacts due to flows or pollutants in any receiving water, even as we support the City's strategy to transfer water quality or flow <u>improvements</u> to priority watershed sites.

Ecology supports and encourages the development of flexible, creative approaches that provide equivalent or better levels of stormwater management/water quality protection than are required in the Phase II Stormwater Permit. We also support and encourage cities, like Redmond, to take the initiative in designing directed alternative approaches to addressing known water quality problems. We commend the City of Redmond for its efforts to establish such a progressive watershed management strategy and look forward to working with the City's staff to finalize and implement this approach.

Sincerely,

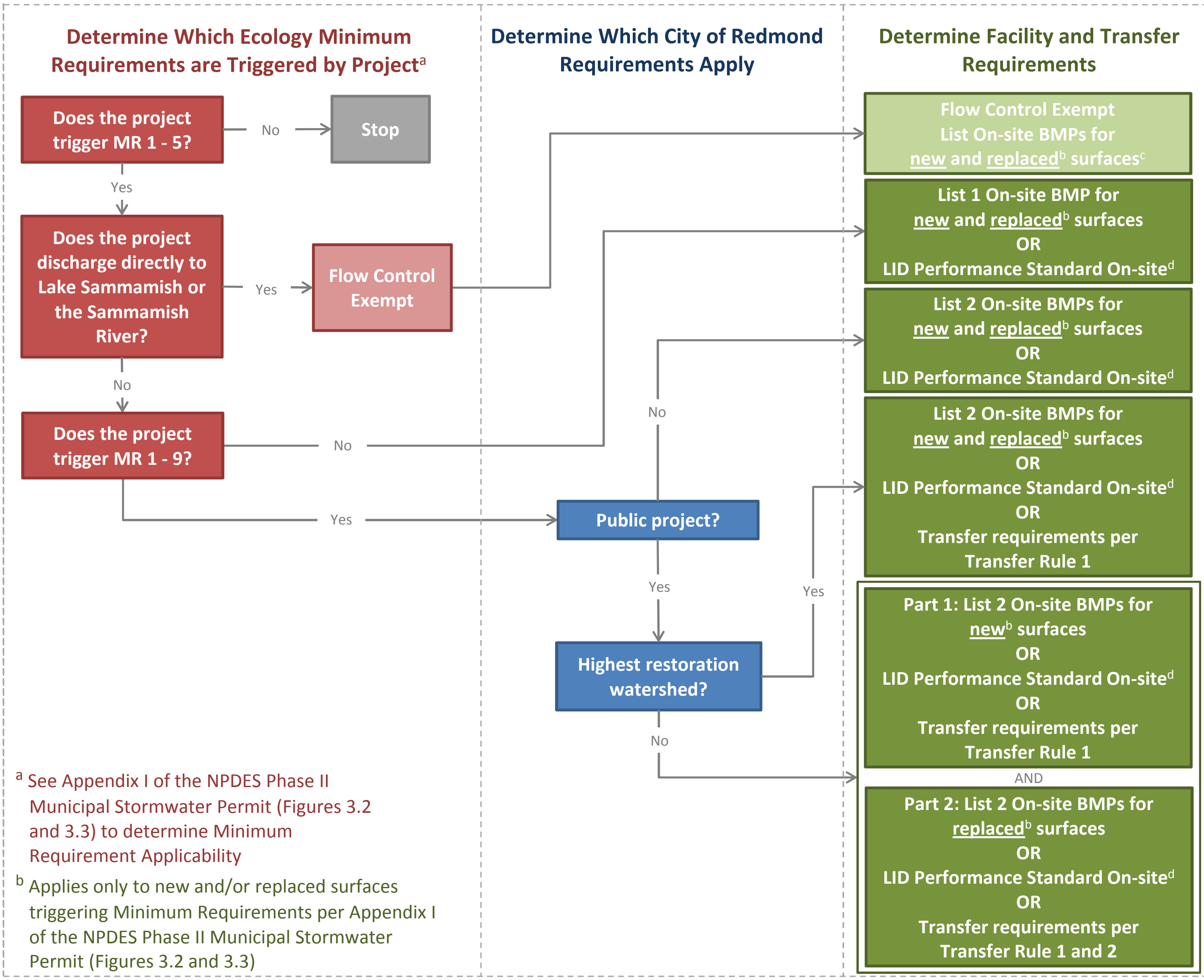
Anne Dettelbach
Municipal Stormwater Permit Specialist

cc: Ed O'Brien
Kevin Fitzpatrick
Raman Iyer
NWRO Permit File

APPENDIX B

Modifications to Default NPDES Permit Requirements

City Of Redmond
Watershed Management Approach to Onsite Stormwater Management
Minimum Requirement (MR) 5



[a] See Appendix I of the NPDES Phase II Municipal Stormwater Permit (Figures 3.2 and 3.3) to determine Minimum Requirement Applicability

[b] Applies only to new and/or replaced surfaces triggering Minimum Requirements per Appendix I of the NPDES Phase II Municipal Stormwater Permit (Figures 3.2 and 3.3)

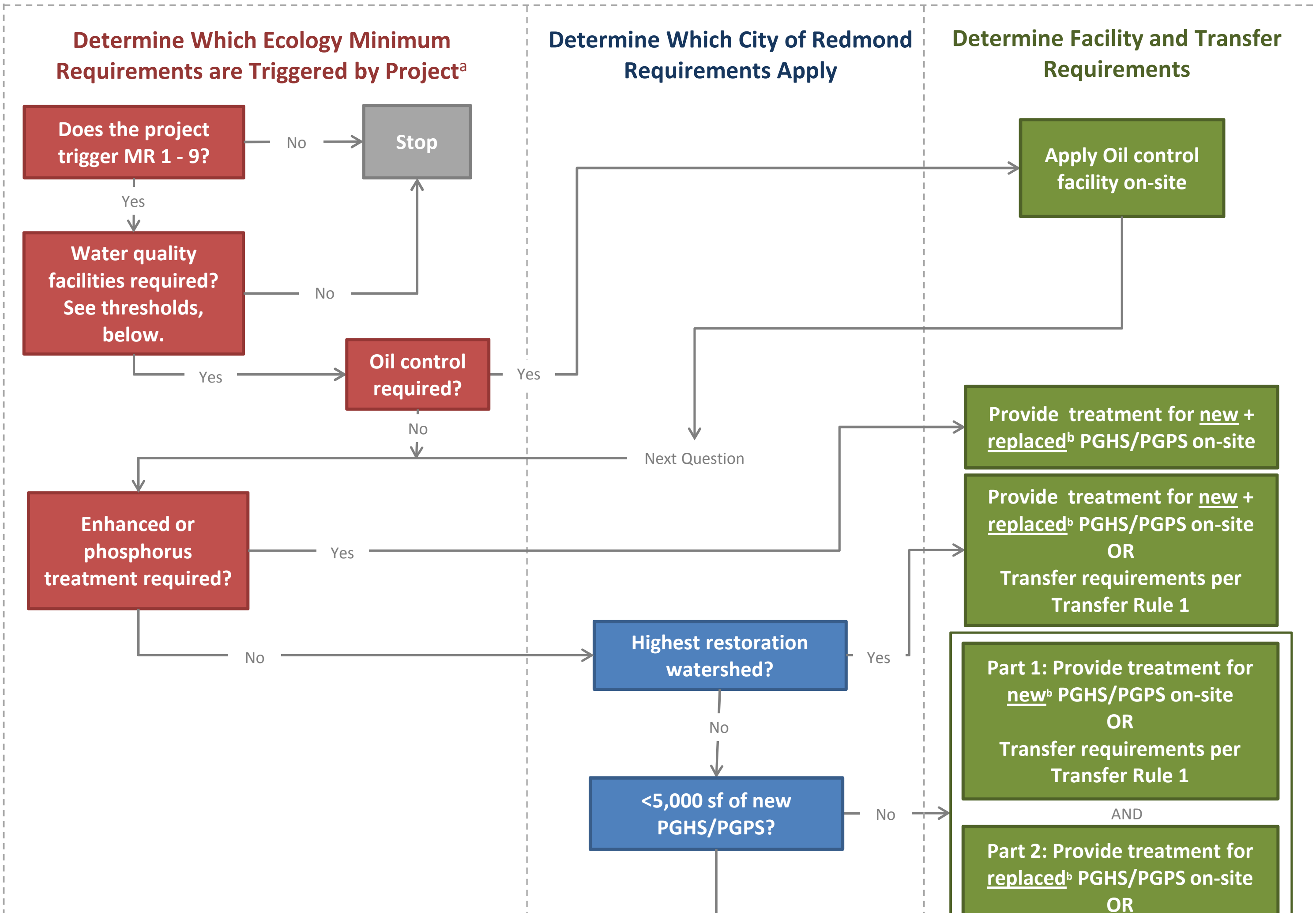
[c] Flow Control Exempt BMP List
Lawn and Landscaped Areas: Post Construction Soil Quality and Depth (T5.13) **Roofs:** Downspout Full Infiltration (T5.10A) Downspout Dispersion Systems (T5.10B) Perforated Stub-out Connections (T5.10C) **Other Hard Surfaces:** Downspout Full Infiltration (T5.10A) Sheet Flow Dispersion (T5.12)

Transfer Rule 1	**If City has capacity, transfer MR5 requirements to another site within the <u>same</u> watershed that discharges within 1/4 mile downstream or anywhere upstream of the project discharge location***
Transfer Rule 2	**If City has capacity, transfer MR5 requirements to another site within a highest restoration watershed***

* Note that the LID performance standard shall be acheived for all LID--related requirement transfers

[d] LID Performance Standard
New /Replaced Hard Surfaces & Disturbed Pervious: Post-developed conditions to match pre-developed (forest) conditions from 8% of the 2-year up to 50% of the 2-year, predeveloped flows.

City Of Redmond
Watershed Management Approach to Runoff Treatment
Minimum Requirement (MR) 6



[a] See Appendix I of the NPDES Phase II Municipal Stormwater Permit (Figures 3.2 and 3.3) to determine Minimum Requirement Applicability

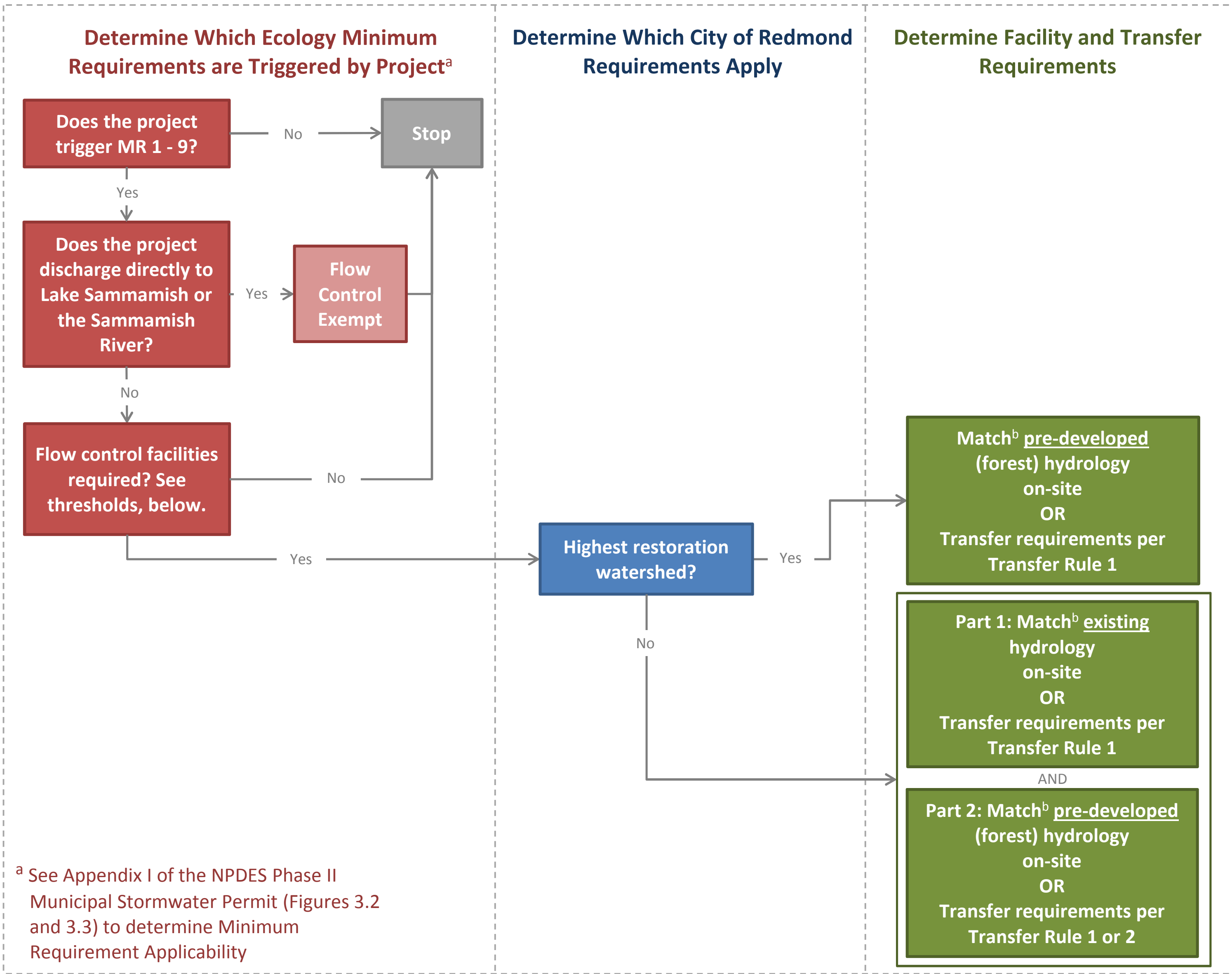
[b] Applies only to new and/or replaced surfaces triggering Minimum Requirements per Appendix I of the NPDES Phase II Municipal Stormwater Permit (Figures 3.2 and 3.3)

Thresholds forRunoff Treatment
≥5,000sf pollution-generating hard surface (PGHS)? OR ≥3/4 acre of pollution-generating pervious surface (PGPS)?

Transfer Rule 1	**If City has capacity, transfer MR6 requirements to another site within the <u>same</u> watershed that discharges within 1/4 mile downstream or anywhere upstream of the project discharge location***
Transfer Rule 2	**If City has capacity, transfer MR6 requirements to another site within a highest restoration watershed***

* Note that treatment must be provided for an area or land use with an equal or higher pollution potential relative to the land use treated by the on-site facility (land uses are prioritized in decending order of pollution potential as follows: high-use roads, industrual, commercial, multi-family, low-use roads, high-density residential, medium-density residential, and low- and rural-density residential)

City Of Redmond
Watershed Management Approach to Flow Control
Minimum Requirement (MR) 7



Thresholds for Flow Control

≥10,000sf EIS?
OR
≥3/4 acre of vegetation converted to lawn or landscape?
OR
≥2.5 acres of more of native vegetation converted to pasture?
OR
≥0.1cfs increase in 100-year flow frequency?

Transfer Rule 1	**If City has capacity, transfer MR7 requirements to another site within the <u>same</u> watershed that discharges within 1/4 mile downstream or anywhere upstream of the project discharge location**
Transfer Rule 2	**If City has capacity, transfer MR7 requirements to another site within a highest restoration watershed**

[b] Performance Standard

New /Replaced Hard Surfaces & Disturbed Pervious:
Post-developed conditions to match existing or pre-developed (forest) conditions from 50% of the 2-year through the full 50-year predeveloped flow.

APPENDIX C

Table Summarizing Multiple Benefits from Green Infrastructure BMPs

Green Infrastructure Benefits and Practices

This section, while not providing a comprehensive list of green infrastructure practices, describes the five GI practices that are the focus of this guide and examines the breadth of benefits this type of infrastructure can offer. The following matrix is an illustrative summary of how these practices can produce different combinations of benefits. Please note that these benefits accrue at varying scales according to local factors such as climate and population.

Benefit	Reduces Stormwater Runoff											Improves Community Livability						
Practice	Reduces Water Treatment Needs	Improves Water Quality	Reduces Grey Infrastructure Needs	Reduces Flooding	Increases Available Water Supply	Increases Groundwater Recharge	Reduces Salt Use	Reduces Energy Use	Improves Air Quality	Reduces Atmospheric CO_2	Reduces Urban Heat Island	Improves Aesthetics	Increases Recreational Opportunity	Reduces Noise Pollution	Improves Community Cohesion	Urban Agriculture	Improves Habitat	Cultivates Public Education Opportunities
Green Roofs	Yes	Yes	Yes	Yes	No	No	No	Yes	Yes	Yes	Yes	Yes	Maybe	Yes	Maybe	Maybe	Yes	Yes
Tree Planting	Yes	Yes	Yes	Yes	No	Maybe	No	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Maybe	Yes	Yes
Bioretention & Infiltration	Yes	Yes	Yes	Yes	Maybe	Maybe	No	No	Yes	Yes	Yes	Yes	Yes	Maybe	Maybe	No	Yes	Yes
Permeable Pavement	Yes	Yes	Yes	Yes	No	Maybe	Yes	Maybe	Yes	Yes	Yes	No	No	Yes	No	No	No	Yes
Water Harvesting	Yes	Yes	Yes	Yes	Yes	Maybe	No	Maybe	Maybe	Maybe	No	No	No	No	No	No	No	Yes

● Yes ◐ Maybe ○ No

APPENDIX D

Effectiveness Monitoring Plan

Introduction

The goal of the City of Redmond's Watershed Management Plan (WMP) is to coordinate internal planning efforts with other state and federal regulatory drivers to direct rehabilitation projects to watersheds where they will provide the most ecological benefit by restoring healthy aquatic habitat for fish and wildlife. As individual waterbodies are rehabilitated, additional watersheds will be prioritized for improvement through updates to the WMP until all the City's waterbodies have been rehabilitated. Without monitoring trends in the associated streams in response to improvements made through this WMP, it will not be possible to demonstrate empirically that the City's actions were effective at achieving the goal of restoring these watersheds by 2060. Therefore, an Effectiveness Monitoring Plan (Plan) has been developed as a companion document to the WMP for evaluating long-term trends in the City's streams. An overview of this proposed Plan is presented herein; the specific details of the Plan will be identified in a Quality Assurance Project Plan (QAPP) to be developed following formal approval of the WMP.

Study Design

This section presents the proposed study design for assessing the efficacy of the WMP. The monitoring program is designed to address the following hypothesis:

> Focused rehabilitation efforts through implementation of the WMP will result in measureable habitat, hydrology, and water quality improvements that fully restore beneficial uses (i.e., fish use) in priority watersheds to pre-disturbance conditions.

In order to ensure that measureable differences are detected in the priority watersheds, the confounding effects of natural variability in habitat, hydrology, and water quality must be reduced through rigorous experimental design. This section discusses the experimental design.

Study Sites

The monitoring network for the Plan will consist of six stations located near the mouths of six watersheds within Redmond. The WMP assigned all watersheds within the City to one of four watershed management strategies: Protection, Highest Restoration, Restoration, and Restoration Development. Pursuant to this experimental design, two reference sites will be established in watersheds prioritized for Protection (watersheds which are relatively pristine); two control sites will be established in watersheds prioritized for Restoration Development (watersheds which are impaired and not targeted for intensive stormwater management); and two treatment sites will be established in watersheds prioritized for Highest Restoration (watersheds which will be targeted for intensive stormwater management retrofits and stream habitat restoration projects). Table D-1 presents the specific watersheds that have been identified for this purpose.

Because large construction projects in any of the watersheds could cause a disturbances that mask trends of interest related to the WMP implementation, the control and treatment watersheds were specifically selected to minimize this potential based on a review of anticipated development and redevelopment patterns.

Table D-1. Study Watersheds and Watershed Characteristics.			
Watershed Type	**Basin Name**	**Dominant Land use/cover**	**Watershed Area (acres)**
Protection (Reference)	Colin	forest	90
Protection (Reference)	Seidel	forest	615
Highest Restoration (Treatment)	Monticello	Single family residential	315
Highest Restoration (Treatment)	Tosh	Single family residential	299
Restoration Development (Control)	Villa Marina	Commercial	589
Restoration Development (Control)	Country	Commercial	212

Approach

This study is designed as a long-term ambient monitoring program consistent with the 2060 target in the WMP for full restoration of the treatment watersheds. At each monitoring station, biological, physical habitat, sediment quality, and water quality will be monitored. The specific monitoring parameters and frequency of monitoring are presented in Table D-2. These parameters were selected to be consistent with the status and trends monitoring in small streams that will be implemented pursuant to the Regional Stormwater Monitoring Program (RSMP) (Ecology 2011).

According to schedule identified in Table D-2, biological, physical habitat, and sediment quality will be assessed over a defined reach length at each station either annually or once every five years. Because water quality and flow characteristics of the watersheds are more responsive to upstream activities and are associated with a high degree of variability, more frequent assessment of these characteristics is required. Water quality data sondes will be deployed at each station to collect temperature, dissolved oxygen, pH, conductivity, and turbidity data on a 15-minute time step. In addition, gauging stations will be installed to continuously monitor stream flow on a 15-minute time step. Rating curves will be developed for each gauging station so that water level measured at each station can be converted to estimates of stream discharge. In addition to the continuous water quality monitoring, one base grab flow sample and two storm flow grab samples will be collected during each quarter and assessed for the parameters listed in Table D-2. These data will be used in conjunction with the flow data and continuous water quality data to produces estimates of pollutant loading from each basin.

As the WMP is implemented between 2014 and 2060, stormwater management efforts designed to fully restore beneficial uses will be focused on the target watersheds. Meanwhile, the reference watersheds will be protected from further development, while the control watersheds will be managed so that habitat is not further degraded. Data will be collected to determine if a clear inter-annual trend in the measured parameters can be detected in the treatment watersheds relative to the control and reference watersheds. The study is designed with enough flexibility that either the control or reference watersheds can be compared with the treatment watersheds. A seasonal Kendall-Tau trend analysis will be performed on each dataset to determine if conditions in the treatment watersheds are varying through time independent of the control and reference watersheds. In addition, the trend analysis will be

Table D-2. Monitoring Parameters and Frequency.	
Parameter	**Frequency**
Biological	
Aquatic macroinvertebrates	Annually
Periphyton Fish diversity, abundance	Once every 5 years
Physical Habitat	
Slope and bearing Wetted width Bankfull width Bar width Residual depth Channel geometry Bank stability Bed scour/deposition Substrate size Pool/Riffle Shade Human influence Riparian vegetation Large woody debris	Once every 5 years
Sediment Quality	
Metals (Cu, Zn, As, Cd, Hg) Poly aromatic hydrocarbons Total organic carbon Grain Size	Annually
Water Quality	
Total phosphorus Orthophosphate Total nitrogen Nitrate + Nitrite Nitrogen Ammonia Total suspended solids Chlorine Dissolved Cu Dissolved Zn Hardness Dissolved organic carbon Fecal coliform bacteria Temperature Dissolved oxygen pH Specific conductance Turbidity	4 base, 8 storm / year (1 base and 2 storm per quarter)

Table D-2 (continued). Monitoring Parameters and Frequency.

Parameter	Frequency
Temp Dissolved oxygen pH Specific conductance Turbidity	Continuous
Hydrology	
Flow	Continuous

performed to determine if conditions in the treatment watersheds are improving over the years such that they more closely resemble those in the reference watersheds. The dataset will also be used to assess that conditions in the control watersheds are not worsening through time. Though many parameters will be monitored, the B-IBI will be used as the primary criterion to determine if beneficial uses are being restored in the treatment watersheds. Monitoring will begin at least 1 year prior to the implementation of the first major BMPs in the treatment watersheds. This 1 year will provide baseline data for the initiation of the trend analysis.

Reporting

On an annual basis during implementation of the monitoring, data quality assurance reports will be issued to assure that the QAPP is being properly implemented. These reports will be designed to highlight any deviations from the QAPP and correct any data quality issues; however, they will not provide detailed summaries or analyses of the compiled data. Every 5 years during implementation of the monitoring, data analysis reports will be prepared to present detailed summaries of the compiled data and results from trend analyses. Further details on the content of the data quality assurance reports and the data analysis reports will be presented in the project QAPP.

References

Ecology. 2011. 2012 Status and Trends Stormwter Monitoring and Assessment Strategy for Small Streams; An Addendum to Quality Assurance Monitoring Plan for Watershed and Health and Salmon Recovery. DRAFT. Washington State Department of Ecology, Olympia, Washington.